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MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

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THE MEAN BAROMETRIC PRESSURES ALONG THE VARIOUS CIRCLES OF LATITUDE—A RÉSUMÉ OF DATA

By LOUIS P. HARRISON

[Weather Bureau, Washington, D.C., October 1933]

Occasions sometimes arise when the meteorologist or worker in allied fields has need for the mean values of the barometric pressure along the various circles of latitude. There exist a number of compilations of such data with accompanying studies, but usually these compilations are incomplete, derived from different sources, and scattered in divers publications often unavailable to the worker not having access to an extensive meteorological library. It is therefore desirable to bring together several of the more important of these compilations so that there may be available in one place a complete set of data, so far as published, for latitudes extending from pole to pole. This is the object of the present paper.

Beginning with the North Pole, we have available, first, a set of mean monthly isobaric charts for the North Polar Regions constructed by H. Mohn (1) largely upon the basis of mercurial barometer readings made on the S.S. *Fram* during its voyage and drift with the icepack in the North Polar Seas in connection with the Norwegian Polar Expedition, 1893–96, under the leadership of Fridtjof Nansen. Table 1 shows the monthly mean barometric pressures (reduced to sea level) at the North Pole (latitude 90° N.) according to these charts. The values were obtained by the writer by interpolating [1] between the mean isobars.

TABLE 1.—*Mean barometric pressures at latitude 90° N., according to Mohn*

[Pressures are reduced to 0° C., standard gravity and sea level]

Month	Pressure	Month	Pressure
	Mm Hg		*Mm Hg*
January	760.9	July	758.4
February	762.0	August	759.6
March	760.8	September	758.0
April	763.9	October	760.7
May	762.6	November	760.6
June	758.9	December	760.9

Mohn (loc. cit.) reduced the mercurial barometer readings made every second or fourth hour in the cabin of the S.S. *Fram* to hourly readings by the use of his barograph records. From these he computed the mean monthly barometric pressures corresponding to the track of the ship for each month of the entire voyage. Table 2 shows these data in extenso, with the position of the ship at 0 hour (local meridian time) on the 1st day of each calendar month.

[1] The *tenths* place is not to be regarded as strictly accurate.

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TABLE 2.—*Mean monthly barometric pressures—Voyage of the S.S "Fram"*

[Pressures are reduced to 0° C. standard gravity and sea level]

Month and year	Position at 0 hour on 1st day of month: Lat. N.		Long. E.		Mean pressure	Month and year	Position at 0 hour on 1st day of month: Lat. N.		Long. E.		Mean pressure
1893	°	′	°	′	*Mm of Hg*		°	′	°	′	*Mm of Hg*
August	69	41	60	20	760.0	1895—Con.					
September	76	25	96	35	754.5	February	83	41	103	14	770.4
October	78	56	133	09	761.8	March	83	57	101	43	768.3
November	78	07	135	05	760.0	April	84	10	99	14	764.7
December	78	41	138	39	773.1	May	84	14	93	24	758.6
1894						June	84	37	83	47	755.2
January	78	58	136	48	762.0	July	84	37	74	41	754.1
February	79	52	134	29	755.4	August	84	29	76	10	761.4
March	80	02	135	23	746.3	September	84	42	77	10	753.8
April	80	07	134	57	762.6	October	85	09	79	24	765.5
May	80	45	131	29	765.7	November	85	40	70	22	755.9
June	81	31	122	16	758.1	December	85	28	58	37	761.3
July	81	33	122	49	756.4	1896					
August	81	03	126	18	761.2	January	85	21	46	19	755.4
September	81	10	125	37	758.0	February	84	51	29	36	748.9
October	81	07	122	02	756.1	March	84	07	26	20	760.4
November	82	06	112	17	761.3	April	84	19	22	54	761.9
December	82	10	110	40	750.4	May	84	11	12	08	760.1
1895						June	83	34	12	29	762.5
January	83	21	102	25	762.0	July	82	57	11	57	758.4

The position of the *Fram* at midnight July 31, 1896, was lat. 81°28′ N., long. 13°20′ E.

Dr. Franz Baur (2) recently published a paper in which he gave the following table (table 3) for the mean barometric pressures at sea level for several circles of latitude and the North Pole. These data are based on mean monthly isobaric charts which he constructed for the Arctic regions. By far, most of the data serving as the basis for these charts were for stations lying between latitudes 64° N. and 80° N. The data derived from the voyage of the *Fram* also were used. Wherever possible, Baur attempted to reduce the data based on short periods of record to "long-period normals." The well-known "Method of the Differences of the Corresponding Observations" was employed for this purpose, (usually) two nearby stations having long periods of record serving as the points of departure. The data given in the table for the various circles of latitude were obtained by taking the arithmetic mean of the pressures found on the isobaric charts at the intersections of each given circle with each 10° meridian (i.e., 0°, 10°, 20° to 180° E. and W. of Greenwich).

TABLE 3.—*Mean barometric pressures (mm Hg) at various circles of latitude, according to Dr. Baur*

[Pressures are reduced to 0° C., standard gravity and sea level]

Circle of latitude	January	February	March	April	May	June	July	August	September	October	November	December	Annual
90° N	760. 2	760. 6	763. 2	765. 1	765. 1	760. 0	757. 9	759. 1	759. 5	761. 3	761. 7	762. 1	761. 3
80° N	759. 5	760. 1	762. 7	764. 4	763. 9	759. 7	758. 4	758. 8	758. 4	760. 3	760. 8	761. 4	760. 7
75° N	758. 9	759. 7	761. 4	763. 1	762. 4	759. 3	758. 6	758. 6	757. 4	758. 0	759. 2	760. 1	759. 7
70° N	759. 3	760. 4	761. 0	761. 7	760. 9	758. 5	757. 8	758. 1	757. 4	758. 0	758. 6	759. 0	759. 2

In table 4 are shown the mean barometric pressures (reduced to sea level) for several months and the year for various circles of latitude according to the different authorities indicated at the heads of the columns by the symbols (T), (S), (K), (F), and (M), respectively. The authorities which these symbols represent and the sources from which they derived their data respectively are: (T), Teisserenc de Bort (**3**)—mean isobaric charts constructed by himself; (S), Spitaler (**4**)—mean isobaric charts given by Hann (**5**) in Berghaus' Physikalischer Atlas; (K), Kaiser (**6**)—mean annual isobaric chart given by Hann (loc. cit.); (F), Ferrel (**7**)—mean isobaric charts constructed personally; and (M), Meinardus (**8**)—results of barometric pressure observations made by various antarctic expeditions and by various observatories in high southern latitudes during the international meteorological cooperation of 1901–04 (**9**).

TABLE 4.—*Mean barometric pressures (mm Hg) reduced to sea level for various circles of latitude according to indicated authorities: (T), (S), (K), (F), (M)*

[Barometric pressures throughout corrected to 0°C. and standard gravity]

Latitude	January	January	March	July	July	October	Year	Year
	(T)	(S)	(T)	(T)	(S)	(T)	(K)	(F)
90° N	-------	-------	-------	-------	-------	-------	761. 2	-------
85	-------	-------	-------	-------	-------	-------	761. 1	-------
80	-------	757. 7	-------	-------	758. 8	-------	760. 6	760. 5
75	-------	758. 3	-------	-------	758. 2	-------	760. 2	760. 0
70	-------	760. 4	-------	-------	757. 6	-------	759. 8	758. 6
65	-------	761. 7	-------	-------	757. 4	-------	759. 8	758. 2
60	759. 9	761. 2	760. 3	758. 3	757. 5	758. 3	759. 4	758. 7
55	761. 8	760. 9	759. 2	758. 6	757. 9	758. 9	759. 7	759. 7
50	762. 4	762. 3	760. 9	759. 2	758. 7	760. 8	760. 5	760. 7
45	763. 4	762. 7	761. 9	760. 0	759. 4	762. 5	761. 6	761. 5
40	764. 5	763. 8	762. 9	760. 4	759. 8	763. 7	762. 2	762. 0
35	765. 6	764. 7	763. 3	760. 1	759. 6	763. 9	762. 2	762. 4
30	765. 3	764. 9	762. 7	759. 6	759. 2	762. 6	761. 6	761. 7
25	763. 8	764. 0	761. 9	758. 6	758. 5	760. 9	760. 4	760. 4
20	761. 5	762. 6	760. 6	757. 9	758. 0	759. 7	759. 6	759. 2
15	759. 5	760. 9	759. 3	757. 2	757. 9	758. 6	759. 2	758. 3
10	758. 4	759. 5	758. 6	757. 3	758. 3	757. 8	758. 9	757. 9
5 N	757. 9	758. 7	758. 0	757. 9	758. 9	758. 0	758. 8	758. 0
0	757. 7	758. 2	757. 2	758. 6	759. 4	758. 4	758. 8	758. 0
5 S	757. 6	758. 0	757. 6	759. 6	760. 1	759. 0	759. 0	758. 3
10	758. 3	757. 8	757. 8	760. 8	760. 9	760. 1	759. 4	759. 1
15	758. 4	757. 8	758. 2	762. 2	761. 9	761. 4	760. 0	760. 2
20	759. 0	758. 5	759. 6	763. 3	763. 6	762. 0	760. 8	761. 7
25	759. 7	759. 8	760. 6	764. 8	764. 8	763. 6	761. 5	763. 2
30	760. 0	761. 4	762. 0	764. 8	765. 2	764. 0	762. 0	763. 5
35	761. 2	762. 4	762. 6	963. 6	764. 0	763. 1	761. 9	762. 4
40	761. 9	761. 8	760. 7	761. 1	760. 5	760. 8	761. 0	760. 5
45	757. 1	758. 8	758. 5	757. 9	756. 8	758. 0	758. 1	757. 3
50 S	751. 0	753. 6	755. 3	753. 1	752. 7	753. 9	752. 4	753. 2
	(M)			(M)			(M)	
50 S	-------	752. 9	-------	-------	753. 8	-------	-------	753. 3
55	-------	747. 1	-------	-------	747. 0	-------	-------	746. 9
60	-------	742. 3	-------	-------	741. 3	-------	-------	741. 7
65	-------	742. 4	-------	-------	741. 2	-------	-------	741. 2
70	-------	743. 2	-------	-------	742. 0	-------	-------	741. 9
75	-------	743. 7	-------	-------	742. 4	-------	-------	742. 6
80	-------	744. 1	-------	-------	742. 7	-------	-------	743. 1
85	-------	744. 4	-------	-------	743. 2	-------	-------	743. 3
90° S	-------	744. 5	-------	-------	743. 4	-------	-------	743. 4

It will be noted that the data for January, July, and the year have been derived from two sources in each case. The arrangement of the values in parallel columns makes possible a ready intercomparison. Spitaler (loc. cit.) has given a similar arrangement of data wherein he presents the mean pressures (reduced to sea level) for January and July as deduced by Ferrel (**7**), Teisserenc de Bort (**3**), Baschin (**10**), and Spitaler (**4**). From these four sets of data he computes composite means for the circles of latitude. These results are not reproduced here.

In addition to the compilation of pressures which have already been referred to, mention may also be made of those by de Tillo (**11**) and Kleiber (**12**).

We add, in table 5, the mean monthly pressures (reduced to sea level) obtained at Little America, Antarctica, latitude 78°34'S., longitude 163°48' W., during the First Byrd Antarctic Expedition. These data were kindly made available to the writer by Mr. W. C. Haines (**13**), meteorologist with that expedition.

TABLE 5.—*Mean monthly barometric pressures (reduced to sea level) at Little America, Antarctica (lat. 78°34'S, long. 163°48'W)*

Year and month	Pressure	Year and month	Pressure
1929	*(mm Hg)*	1929	*(mm Hg)*
January	747. 8	August	738. 9
February	741. 9	September	735. 6
March	741. 2	October	733. 3
April	743. 2	November	746. 5
May	734. 6	December	751. 8
June	744. 2	1930	
July	735. 3	January	743. 0

It is instructive to compare for any given circle of latitude the mean pressures reduced to sea level as already presented with the actual pressures averaged over the varying surface elevations above sea level for the same circle. Table 6, taken from Spitaler (**4**), shows the mean *actual* heights of the barometer (barometric pressure *not* reduced to sea level but corrected to 0° C. and standard gravity) for the various circles of latitude. It should be obvious that data of the type given in this table rather than those of the type previously given may serve as a basis in the study of the mean advective movement of the atmosphere between the various latitudinal zones from season to season.[2]

TABLE 6.—*Mean actual barometric pressures (averaged over the varying surface elevations above sea level) for the various circles of latitude, according to Spitaler*

Circles of latitude	January	July	Circles of latitude	January	July
	mm Hg	*mm Hg*		*mm Hg*	*mm Hg*
80° N	717. 1	722. 9	10° N	747. 8	746. 7
75° N	729. 9	733. 0	5° N	749. 9	750. 1
70° N	724. 9	726. 2	0°	747. 2	748. 4
65° N	729. 2	729. 1	5° S	741. 8	743. 8
60° N	732. 0	732. 5	10° S	747. 3	750. 2
55° N	737. 4	737. 6	15° S	740. 5	744. 2
50° N	731. 7	732. 4	20° S	744. 4	749. 0
45° N	731. 4	732. 3	25° S	743. 0	747. 2
40° N	724. 3	724. 8	30° S	748. 6	751. 7
35° N	705. 7	706. 4	35° S	753. 8	755. 1
30° N	726. 0	723. 4	40° S	760. 7	759. 4
25° N	746. 1	741. 8	45° S	756. 4	754. 3
20° N	746. 3	742. 5	50° S	753. 1	752. 2
15° N	754. 0	751. 2			

Table 7-A, from Spitaler (loc. cit.), shows the mean *actual* pressures (i.e. *not* reduced to sea level but corrected to 0° C. and standard gravity) averaged over zones girdling the earth and having a width of 10° of latitude. It is obvious that if we take into consideration the areas of the respective zones we can compute from the data given in table 7-A close approximations to the masses of

[2] The erroneousness of using pressures reduced to sea level rather than actual pressures in the study of the advective movement of air over the globe has already been pointed out by Angot. See Annuaire de la Société Météorologique de France, T. 35, 1887.

air lying over each of the zones, and thus make available numerical values from which we can readily compute the net advective exchange of air across the boundaries of each zone between midwinter and midsummer. Table 7-B, from Spitaler also, shows the (equivalent) masses of air lying over the various zones, the data being expressed in cubic kilometers of mercury. To convert these data to units of mass, the relation: 1 km^3 mercury $= 13.6 \times 10^{12}$ kg mass, may be used.

TABLE 7.—*A. Mean actual pressures (mm Hg) averaged over 10° zones. B. Mean masses of air*[1] *(expressed in km^3 mercury) lying over 10° zones*

Latitudinal limits of zones	A		B		
	January	July	January	July	Difference, January–July
80° to 70° N	726.08	729.05	8,343.0	8,377.0	−34.0
70° to 60° N	729.18	729.56	13,681.3	13,688.4	−7.1
60° to 50° N	734.63	735.03	18,707.0	18,717.1	−10.1
50° to 40° N	729.54	730.28	22,901.6	22,925.3	−23.7
40° to 30° N	715.42	715.20	26,017.1	26,009.4	7.7
30° to 20° N	741.37	737.55	29,829.3	29,675.7	153.6
20° to 10° N	750.53	747.93	32,184.6	32,073.1	111.5
10° to 0° N	748.72	748.84	33,113.1	33,118.5	−5.4
0° to 10° S	744.53	746.55	32,927.7	33,016.9	−89.2
10° to 20° S	743.18	746.90	31,870.0	32,028.6	−158.6
20° to 30° S	744.72	748.73	29,964.0	30,126.0	−162.0
30° to 40° S	754.03	755.20	27,421.3	27,463.8	−42.5
40° to 50° S	756.82	755.22	23,757.9	23,707.8	50.1

[1] Table 7-B is obtained by converting the values given in Table 7-A to km of Hg and multiplying the results thus obtained by the corresponding areas of the 10° zones expressed in km^2. The areas of the 10° zones were determined on the basis of the assumption that the earth is a sphere of radius 6,366.7 km. Table 7-B thus does not represent precisely the mean actual masses of air lying over the zones, divided by the density of mercury, i.e., the volumes of mercury whose masses are equal to the actual masses of air lying over the zones, because the joint effect of the variations of gravity, latitudinally and vertically, has been omitted in computing the data. Thus analytically, table 7-B is given by the expression $A \times B_o$, whereas the volume of mercury whose mass is equal to the mass of air lying over the zone is given by the expression $A \times B_o \times g_s/g_m$, where A = area of zone (km^2); B_o = mean height (km) of mercury in the barometer at the surface of the zone, when reduced to standard temperature (0° C.) and standard gravity; g_s = standard gravity = 980.665 cm/sec²; and

$$\frac{1}{g_m} \equiv \frac{-\int_{B_o}^{0} \frac{dB}{g}}{B_o},$$

in which g = value of gravity in the free air corresponding to the height above the surface of the zone where the barometer (reduced to standard conditions of temperature and gravity) is B in general, conditions being assumed average for the zone. Calculation shows g_m to correspond to the value of gravity at about 7,500 m elevation above sea level. Hence for the zone 0°–10°, $g_s/g_m = 1.0050$, and for the zone 70°–80°, $g_s/g_m = 1.0001$, approximately. Also, if the earth had been considered as a spheroid instead of a sphere, slightly different results would have been obtained for the areas of the zones. See, for example, p. 142, Smithsonian Geographical Tables, Smithsonian Institution, Washington, D.C., 1906.

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HEAVY RAINFALL IN GEORGIA

By GEORGE W. MINDLING

[Weather Bureau, Atlanta, Ga., Sept. 15, 1933]

The St. George record.—Georgia lies within a region that is remarkable for its excessive rains. The greatest 24-hour rainfall on record in the State is 18 inches at St. George on August 28–29, 1911. This record when made had been equaled once in Texas and exceeded once in Louisiana. At the present it has been surpassed three times in Texas, twice in Louisiana, and once each in Alabama, Florida, and North Carolina. The greatest of these was 23.22 inches at New Smyrna, Fla., October 9–10, 1924.

The St. George record is more than double that in connection with any outstanding flood of the northern part of the United States, including that of Johnstown, Pa., in May 1889; the Great Miami River flood of March 1913 at Dayton, Ohio; and the Vermont flood of November 1927.

Greatest 24-hour rainfall, by States.—Rainfall of 10 inches or more within 24 hours has never been measured in several of the Northern States, and, in some of the Rocky Mountain States not even as much as 5 inches.

Twenty-four-hour rainfalls of 15 inches or more are unknown in this country except in some of the States adjacent to the coast from North Carolina to Texas and in California. Complete data are not available for South Carolina and Mississippi, but for the other States in the regions indicated the maximum amounts for 24 hours are:

State	Amount	Place	Date
	Inches		
North Carolina	22.22	Altapass	July 15-16, 1916.
Georgia	18.00	St. George	Aug. 28-29, 1911.
Florida	23.22	New Smyrna	Oct. 9-10, 1924.
Alabama	20.00	Elba	Mar. 14-15, 1929.
Louisiana	21.40	Alexandria	June 15-16, 1886.
Texas	23.11	Taylor	Sept. 9-10, 1921.
California	16.81	Squirrel Inn	Jan. 17, 1916.

South Carolina is known to have had a record of 13.25 inches in July 1916, and Mississippi one of 12.35 inches in the same month and year.

Ten-inch rains in Georgia.—These extraordinary rainfalls usually have been directly associated with storms of tropical origin. All known instances of 24-hour rains of 10 inches or more in Georgia, except one at Blakely in March 1929, resulted from West Indian hurricanes that passed over the southern part of the State or close to the coast.

Following is a complete list of the 24-hour rains of 10 inches or more that have been recorded in Georgia:

Amount (inches)	Place	Date
18	St. George	Aug. 28-29, 1911.
10.08	Savannah	Sept. 15-16, 1924.
11.44	do	Sept. 17-18, 1928.
10.40	Savannah (2)	Do.
10.88	Blakely	Mar. 15, 1929.
15	Glennville	Sept. 27, 1929.
12.75	Brooklet	Do.
10.45	Meldrim	Sept. 5-6, 1933.

Ten-inch rains in other States.—Lists of such rains within 24 hours have been obtained from the climatological centers of the various sections and are partly summarized in the following table, the records in the respective States beginning with the year indicated and extending through 1932.

Section	Year record began	Number of months with 10 inches or more	Most local instances 10 inches or more in one month	Greatest 24-hour rainfall on record
				Inches
Alabama	1884	14	6	20.00
California	1897	9	5	16.81
Florida	1892	24		23.22
Georgia	1892	5	2	18.00
Iowa	1873	6	4	[1] 16.00
Louisiana	1891	16	3	21.40
Maryland-Delaware	1868	3	1	14.75
North Carolina	1887	3	7	22.22
Tennessee	1884	3	1	[1] 14.98
Texas	1891	35	5	23.11

[1] Unofficial, but well authenticated measurements.

When allowance is made for length of record and the number of stations in the different sections, it is evident that Georgia is surpassed as to heavy rains only by Alabama, Florida, Louisiana, and Texas.

Records of 10 inches or more have been made in only 2 different months each in Arkansas, Missouri, Nebraska, and Wisconsin, with maximum amounts ranging from 11.25 to 12.25 inches. A single instance of 10 inches or more has been recorded in each of the following States with a maximum of 12.18 inches in Oregon: Illinois, Indiana, Kansas, Minnesota, Montana, New York, Oklahoma, Oregon, Rhode Island, and Washington.

Lesser heavy rains.—Georgia's prominence as to heavy rains does not rest on a few cases of enormous downpours of 10 to 18 inches, but is supported also by the frequent occurrence of 24-hour rains of 5 inches or more, 3 inches or more, 1 inch or more, and an imposing array of instances of prolonged heavy rains extending over several days.

Greatest 24-hour rainfalls at 52 stations.—The greatest 24-hour rainfalls have been determined by months and years for 52 stations having the most satisfactory long records in Georgia. Only 3 of these stations have never had as much as 5 inches in 24 hours; 23 have had over 7 inches; 15, over 8 inches; and 5, over 10 inches.

The maximum amounts on record show a strong tendency to occur in either the late summer or early spring. The following table shows the number of stations having their maximum amounts in each of the respective months.

January	1	July	2
February	4	August	9
March	10	September	15
April	5	October	4
May	1	November	0
June	0	December	1

Monthly charts of the greatest 24-hour rainfall on record for the various stations show only small irregular areas with as much as 5 inches in the cooler season, November to February, inclusive, when the tendency is for the heavier rains to occur in the interior of the State.

In March more than one third of Georgia has had 5 inches or more within 24 hours, chiefly in the western and northern sections. There is an evident letdown in excessive rains during April and May followed by a slight pickup in June and a very marked spread of rainfalls of this intensity in August and September, especially in the southern and eastern parts of the State, which are most strongly affected by storms of tropical origin.

October has fewer heavy rains than September, and the 5-inch area for this month is limited chiefly to the upper Savannah River watershed.

Greatest 24-hour rainfall in Georgia, by months.—The greatest 24-hour rainfall in the State has been compiled for each month through a period of 38 years, together with the number of local instances of 5 inches or more. In this period 104 months had 5 inches or more within 24 hours somewhere in the State, an average of little less than 3 such months to the year. The number of instances of such rainfall at different stations (including any instances at the same station in different months) was 286.

The following is a list of the months in which 10 or more stations recorded 5 inches or more of rain within 24 hours.

Month:	Number of stations
September 1901	11
September 1903	10
July 1916	13
August 1928	10
March 1929	10
September 1929	12
October 1929	10
September 1933	10

The months of occurrence of 24-hour rains of 5 inches or more somewhere in the State were as shown in the following table for this 38-year period. Note the prominence of the July to October season, the sharp falling off in November, the winter pickup culminating in March, and the secondary letdown in April and May.

Occurrence of 5 inches or more in 24 hours somewhere in the State

Month:

Month	Different years	Month	Different years
January	3	July	13
February	8	August	13
March	14	September	18
April	7	October	10
May	4	November	2
June	6	December	6

The trends shown here follow roughly the variations in the monthly normals of total precipitation except in September and October, when the heaviest rains are much above the usual ratio to the normal rainfall of the season.

Five-inch rains by stations.—The number of occurrences of 5 inches or more in 24 hours was determined for 52 stations for the 25-year period 1908–32. Only 6 of these had no 5-inch rains within this period; 21 had 3 or more such occurrences; and 6 had 6 or more.

Three-inch rains by stations.—The number of occurrences of 3 inches or more for the same 25-year period has been determined for 45 stations. The total number of such occurrences during these 25 years ranges from 10 at Gainesville to 47 at Marshallville. Only 15 of the stations had fewer than 20 such occurrences, and 19 had 25 or more.

There are two regions of noticeable frequency of such rains. The first extends across the middle of the State from around Columbus to beyond Macon; the second covers the southern part of the State northward as far as Blakely at the west and far beyond Brunswick on the coast, though falling short of Alapaha and Waycross.

These heavy rains have their least frequency below the mountain area in the northern section of the State, particularly from near Tallapoosa and Rome to about Hartwell and Augusta. A region of similar low frequency appears in the southeastern part of the State back of the coast counties.

One-inch rains.—The high frequency of rains of 1 inch or more in 24 hours prompted the writer to determine the number of days with such amounts and the percentage of total rainfall occurring in daily quantities of 1 inch or more. This investigation was limited to 26 representative stations and to the 20 years, 1911–30.

The average annual number of days with 1 inch or more shows little variation over the State, ranging from 12 to 16, except in the extreme northeastern section, where the Clayton record gives an annual average of 27. The greatest number of such days at Clayton for any single year was 39; and the greatest number for any month was 10, in July 1916.

The total number of days with 1 inch or more in the 20 years was greatest in July, ranging from 19 at Athens to 50 at Clayton and 51 at Waycross; and least in November, from 11 at St. George and Savannah to 22 at Rome.

Percentage of rainfall in amounts of 1 inch or more.—Before making this investigation the writer had the impression that not less than half of Georgia's total precipitation comes in amounts of an inch or more within 24 hours, and the facts ascertained gave substantial support to that original idea.

Beginning with the Atlanta record and using for convenience the daily amounts (midnight to midnight) there was found a total of 442.26 inches occurring in daily amounts of 1 inch or more during the 20 years, 1911–30. This is 46 percent of the entire precipitation for the period. Later the same 20-year period was examined and a compilation made of all rainfall of an inch or more falling within periods of 24 consecutive hours. Of course, a considerably larger amount was obtained than by the first method, the result being 521.10 inches, or 54 percent of the entire precipitation for the period.

To make the investigation fairly conclusive it was extended through the records of 25 stations well distributed over the State and covering the same 20-year period that had been used for Atlanta. On the basis of daily amounts as entered in the original records the percentages came out mostly in the upper forties, though ranging from 44 at Athens to 66 at Clayton.

Were it possible to determine accurately the greatest amount of rainfall for periods of 24 consecutive hours in each instance throughout these records, there is no doubt that the percentage of the total rainfall occurring in amounts of an inch or more would prove to be well above 50 for the State as a whole, as was found in the case of Atlanta.

The following table shows the most important results of the investigation for some of the better-known stations:

Precipitation in daily amounts of an inch or more in the 20-year period, 1911–30

Stations	Total number of days	Average annual amount	Percent of entire precipitation
Albany	319	26.65	51
Americus	307	25.19	51
Athens	263	21.40	44
Atlanta	274	22.11	46
Augusta	257	21.13	47
Bainbridge	295	25.56	50
Brunswick	289	26.11	52
Clayton	546	46.70	66
Columbus	261	22.56	46
Gainesville	314	24.56	45
Macon	246	21.71	47
Newnan	318	24.90	49
Rome	310	24.32	45
Savannah	258	22.45	48
Thomasville	305	26.57	51
Waycross	295	24.84	49

The percentage of total rainfall occurring in daily amounts of an inch or more is greatest in the northeastern mountain area, 66 at Clayton, from which it falls off to from 45 to 50 throughout the rest of the State, except across the southern portion, where it is slightly over 50.

One-inch rains by months.—The average amounts of rainfall occurring in quantities of an inch or more per day were determined by months for the 25 stations investigated, and it was found that the months of prominence generally are March and July. However, 5 stations had their monthly maximum in September, 2 in August, and 1 each in December and January.

Prolonged heavy rains.—One of the most interesting and important aspects of heavy rainfall in Georgia is the occasional occurrence of prolonged heavy rains for several days over extensive areas. When such a condition occurs, a rapid rise in the rivers is certain to follow, especially if the ground is fairly well saturated with moisture before the heavy rains begin. If at the same time the weather is cold enough to prevent much evaporation and vegetation is dormant or nearly so, the floods are still greater.

The following paragraphs indicate the intensity of the more important flood-producing rains in Georgia during the past 35 years and show the resulting rises in the rivers within the areas chiefly affected.

Heavy rains of March 22–24, 1908.—The rainfall at 15 stations, practically limited to a 2-day period, averaged 5.87 inches.

River	Total rise	Crest stage	Place	Days time
Savannah	20.1	29.6	Augusta	5
Oconee	21.1	25.8	Milledgeville	3
Chattahoochee	36.5	42.0	Eufaula	3
Do	28.6	36.5	Alaga	4

Heavy rains of March 13–16, 1913.—The rainfall at 10 stations in from 2 to 4 days averaged 7.09 inches.

River	Total rise	Crest stage	Place	Days' time	Rise in 1 day (feet)
Savannah	20.8	35.1	Augusta	3	11.5
Oconee	27.0	33.0	Milledgeville	5	11.6
Ocmulgee	23.2	27.0	Hawkinsville	6	
Flint	23.8	30.3	Albany	8	
Chattahoochee	32.5	54.5	Eufaula	4	14.7
Do	24.4	40.2	Alaga	5	12.8
Oostanaula	13.0	25.0	Resaca	4	
Coosa	16.6	25.0	Rome	3	

Heavy rains of July 7–11, 1916.—There was an average of 8.93 inches of rain in from 2 to 5 days (3 days in most cases) at 34 stations, just half the stations then in operation within the State. At Blakely 21.69 inches fell within 4 days; 6 other stations had over 10 inches each within 3 days.

River	Total rise	Crest stage	Place	Days' time	Rise in 1 day (feet)
Savannah	18.9	28.4	Augusta	3	
Ocmulgee	24.9	28.1	Hawkinsville	7	
Flint	20.4	22.3	Montezuma	5	
Do	24.0	25.0	Albany	4	10.7
Do	24.4	28.7	Bainbridge	5	10.5
Chattahoochee	48.6	52.4	Eufaula	4	38.8
Do	40.2	44.0	Alaga	2	29.0
Etowah	22.9	23.9	Canton	3	
Oostanaula	19.9	23.4	Resaca	3	11.0
Coosa	27.7	34.3	Rome	5	14.6

The rise of practically 39 feet cited here as occurring within 1 day at Eufaula on the Chattahoochee River is the most rapid rise ever known to have occurred at that station, and possibly it never has been exceeded anywhere in Georgia. The first 40 feet of the rise was produced by an average rainfall of about 5 inches over the drainage area above Eufaula, but during the entire period of heavy rain the average was about 9 inches and the total rise 48.6 feet.

Heavy rains of December 7–10, 1919.—The rainfall at 21 stations (mostly within 3 days) averaged 8.05 inches. Atlanta had 11.75 within 3 days. Rivers rose as indicated below. The river stage at West Point was the highest of record at that station.

River	Total rise	Crest stage	Place	Days' time	Rise in 1 day (feet)
Savannah	28.4	35.4	Augusta	4	19.5
Broad	25.3	28.0	Carlton	3	15.0
Oconee	26.9	31.4	Milledgeville	5	10.3
Do	24.0	24.0	Dublin	8	
Ocmulgee	23.3	25.3	Macon	4	10.4
Do	25.9	29.3	Hawkinsville	6	
Apalachicola	21.9	24.9	River Junction	8	
Flint	22.2	24.2	Albany	7	
Chattahoochie	49.6	52.4	Eufaula	4	17.7
Do	36.7	40.7	Alaga	5	18.5
Do	25.9	29.3	West Point	4	

Heavy rains of September 15–16, 1924.—The rainfall at 8 stations averaged 7.83 inches, with over 10 inches at 2 stations. Although there were sharp rises in several of the rivers, there was no flood owing to low initial stages and the dry condition of the ground immediately preceding the heavy rains. So much of the rain was absorbed by the soil that the percentage of run-off was much less than usual. The latter part of the month was wet, and another period of widespread heavy rain set in on the 24th. While the rains of the latter period were a little below the limits fixed for this discussion, the rivers rose rapidly under their influence owing to the wet condition of the soil and consequent higher percentage of run-off. The result was that flood stages were reached in many places before the close of the month.

Heavy rains of January 16–20, 1925.—The rainfall at 22 stations (limited to 3 or 4 days except at 1 station) averaged 8.07 inches. At 2 stations there was over 10 inches within 4 days. The rivers had already risen to fairly high stages as a result of heavy rainfall from the 10th to the 12th of the month. The additional rise brought the streams to the highest stages ever known at several stations and to the second highest at some others. Rivers rose as follows:

River	Total rise	Crest stage	Place	Days' time	Flood stage
Savannah	22.3	36.5	Augusta	4	32
Do	12.3	[1] 30.5	Charlotte	7	12
Oconee	23.6	36.7	Milledgeville	3	22
Do	9.4	[1] 29.8	Dublin	5	22
Ocmulgee	14.7	[1] 27.6	Macon	3	18
Do	10.9	[1] 36.5	Hawkinsville	2	29
Do	6.1	[1] 20.3	Abbeville	8	11
Do	11.9	[1] 26.3	Lumber City	5	15
Apalachicola	10.1	[2] 32.1	River Junction	9	20
Do	5.6	[2] 27.9	Blountstown	12	15
Flint	10.0	[1] 36.6	Albany	5	20
Do	13.7	[1] 40.9	Bainbridge	9	25
Chattahoochee	16.5	24.6	West Point	3	19
Do	37.8	[2] 59.8	Eufaula	4	40
Do	16.2	[2] 44.5	Alaga	5	32

[1] Highest stage on record for the station.
[2] Second highest stage on record for the station.

Heavy rains of August 13–16, 1928.—The rainfall at 8 stations averaged 6.76 inches, following heavy rains in central and southwestern Georgia on the 10th and 11th. The Oconee River at Milledgeville rose to 38.7 feet on the 16th, the highest on record at that station.

Heavy rains of March 14–16, 1929.—The 2-day rainfall at 12 stations averaged 7.46 inches. More than 11 inches fell at 2 different stations within 2 days. The effect of these rains was heightened by two periods of extraordinary rainfall closely preceding. The first of these came on February 27–28 with an average of 6.09 inches for 2 days at 13 stations. The second came on March 4–5 with an average of 5.87 inches for 2 days at 13 stations.

A remarkable series of floods resulted in some places. For example, at Milledgeville the Oconee River reached 35.7 feet (13.7 feet above flood stage) on February 28; it fell to 19.5 on March 4 and rose to 34.7 the next day; then it fell to 9.2 on the 13th and rose to 29.6 on the 16th.

Some portions of the lower Chattahoochee and lower Flint were above flood stages the greater part of March 1929. The Apalachicola was above the flood stage (20 feet as then designated) at Blountstown, Fla., from February 25 to April 3, and above flood stage at River Junction, Fla., from March 1 to 30. The Altamaha at Everett City was above flood stage from February 22 to April 11, and reached the highest stage on record at that station (16 feet) on March 15.

Some of the more remarkable river rises during the latter part of March were as listed below.

River	Total rise	Crest stage	Place	Days' time
Oconee	20.0	29.6	Milledgeville	2
Ocmulgee	14.3	24.7	Macon	2
Do	13.9	32.7	Hawkinsville	4
Flint	15.6	[1] 27.4	Montezuma	3
Do	9.2	[2] 34.4	Albany	6
Chattahoochee	19.7	[2] 26.0	West Point	3
Do	48.6	[1] 63.8	Eufaula	4
Do	26.4	[1] 46.0	Alaga	5
Apalachicola	10.8	[1] 35.0	River Junction	5
Do	5.5	[1] 28.6	Blountstown	6

[1] Highest stage on record for the station.
[2] Second highest stage on record for the station.

Heavy rains of September 25–27, and October 1–2, 1929.—In the first of these periods the rainfall at 19 stations (chiefly limited to 2 days) averaged 9.65 inches. The outstanding instances of heavy rain were:

14.48 inches in 2 days at Double Branches.
14.49 inches in 2 days at Washington.
19.31 inches in 3 days at Brooklet.
10.90 inches in 3 days at Millen.
19.45 inches in 3 days at Glenville.

In the second of these periods the rainfall within 2 days at 23 stations averaged 6.82 inches.

At many places along the rivers there was little or no fall before the second heavy precipitation was draining into the streams. In the following table the rise was computed from the lowest stage immediately preceding the first period of heavy rain except when a greater rise was produced by the second period of rains alone.

River	Total rise	Crest stage	Place	Days' time
Savannah	38.0	45.1	Augusta	7
Oconee	30.3	36.9	Milledgeville	7
Do	25.4	27.6	Dublin	9
Ocmulgee	17.6	24.9	Macon	2
Do	23.5	30.5	Hawkinsville	10
Flint	22.3	25.3	Albany	9
Chattahoochee	42.8	47.0	Eufaula	8
Do	33.1	39.1	Alaga	8

TYPES OF HEAVY-RAIN-PRODUCING STORMS IN GEORGIA

By ARTHUR H. SCOTT

[Weather Bureau, Atlanta, Ga., Oct. 31, 1933]

In any study of the heavy rainfall in Georgia, it is interesting to consider the conditions that cause them and the type of associated storm movement. Georgia, because of its proximity to the Atlantic Ocean and the Gulf of Mexico, has abundant moisture close at hand, and when conditions are present that will cause condensation over the State, it is possible that excessive rains may result. The Blue Ridge Mountains, moreover, covering much of the northern part of the State, and facing the moisture-bearing winds from the Atlantic Ocean, induce abundant precipitation along their eastern slopes. Georgia, furthermore, lies within or near the track of many cyclonic storms. It is well, therefore, to determine what types of storm movement cause heavy rainfall in this State.

Prof. Alfred J. Henry in his article on The Distribution of Excessive Precipitation in the United States in the MONTHLY WEATHER REVIEW, September 1928, vol. 56, page 863, says:

> Finally, the outstanding result of this study is the fact that the atmosphere over the United States, say east of the one hundredth meridian, contains during the warm season a high-water content which awaits only suitable temperature relations in order to produce excessive rains for a short period of time.
>
> The longer excessive rains (24 hours) are due, as a rule, to any of the following conditions: The advent of a tropical cyclone along the Gulf or eastern seaboard; the seemingly fortuitous relatived geographical position with reference to each other of a vigorous extratropical cyclone with a strong anticyclone immediately to the northeast; the same condition, although in a slightly different form, viz, the intrusion of an anticyclone (cold front) into an extensive barometric trough wherein high temperature and vapor content prevail also causes excessive rains for 24 hours and sometimes longer.

As applied to Georgia, these conclusions just quoted hold very well. Georgia occasionally is visited by tropical storms which cause heavy rains over areas far beyond the extent of destructive winds, sometimes even to the northern section of the State. As a rule, the heaviest rainfall occurs east of the track of the center of the storm, especially when it has recurved and is moving northward or northeastward, as in the storms of August 10–11 and 14–15, 1928, September 17–18, 1928; and the storm of July 7–9, 1916, which caused widespread excessive rains. In this connection, it is well to note that occasionally a tropical storm drifting slowly over the State, as in July 1916, leaves the atmosphere so humid and the ground so wet that showers are frequent for several days after the barometric depression has filled up. Naturally, the heavy rainfalls attending tropical storms are limited to the hurricane season, that is, from late June into October, with the greatest frequency in August and September.

Apart from the tropical disturbance, the main rainfall producer during the summer months in Georgia is the thunderstorm. Convective action is at its height during the warm season and the cyclonic movement weak. The Atlantic high pressure area in the vicinity of Bermuda seems to be the dominating factor in the weather control of Georgia, especially during the warm months, for when it shifts to the westward dry weather prevails over much of the eastern portions of the country; but when its western edge is off the Carolinas while a shallow barometric trough extends from the St. Lawrence Valley southwestward over the Ohio and lower Mississippi Valleys, or if the pressure gradient is weak to the west of the high pressure area, with the morning temperatures well up, say to 70° or over, heavy thundershowers are likely to occur locally in Georgia. When a high pressure area west of the barometric trough advances with cooler weather, general thundershowers, often heavy, occur in most cases along the cool front. Similarly, if a high pressure area moving southward over the Atlantic States drifts over Georgia against a shallow trough of low pressure, torrential rains sometimes follow with the cooling of the warm, humid air. A movement of this kind caused particularly heavy rains in southeastern Georgia on September 9–10, 1908.

The occurrence of excessive precipitation is more or less confined to local areas except in the cases of tropical cyclones.[1] The thunderstorm, being the result often of purely local convective action, affects only a limited area, and we have therefore at times single, isolated heavy downpours and at others a series of locally heavy showers. Anything that induces strong vertical convection of

[1] Henry, Alfred J., The Distribution of Excessive Precipitation in the United States. MONTHLY WEATHER REVIEW, September 1928, vol. 56, p. 357.

moisture-laden air causes heavy rains. A case in point is high pressure in the vicinity of Bermuda, accompanied as it is, with warm weather and a quiet inflow of moist oceanic air over a large part of the Southeastern States, including Georgia. Of course, the convective rains usually are of short duration, but sometimes the same pressure relation is maintained for several days at a time, and heavy rains occur in the same locality for 2 or more days in succession.

Convective rains are frequent in southern Georgia during the summer months, July and August, especially. At Blakely, Quitman, and Brunswick in southern Georgia the July normal rainfall amounts are 7.22, 7.28, and 7.16 inches, respectively. Some of this precipitation undoubtedly is due to tropical storms, but the rains occasioned by thundershowers contribute most to the great July normal at these stations.

The official in charge of river work in Georgia should note the conditions that may produce heavy rains in the State even during the summer season, for while floods are least likely to occur during the warm months, yet when heavy rains are more or less general, floods may result. Sometimes a tropical storm causes rains that flood some of the rivers in the State, or again floods may result from general thundershowers. The tropical storm of July 1916 caused general floods in Georgia, and the heavy rains in July 1919 brought floods in some rivers in the State. Rains in August 1908 and in August and September 1928 and September and October 1929 also produced flood conditions in many of the rivers in the State.

Heavy or excessive rainfall in Georgia during the winter, spring, and autumn; that is, during the period when precipitation largely is governed by cyclonic action, usually is caused by a well-developed disturbance centered near or over Georgia. The southwestern LOW, to cause excessive rains in this section, must take the southern route and must move east-northeast to the Carolinas. If there is a strong HIGH over the Atlantic States in front of the LOW, heavy rains are more probable. Similarly, disturbances that develope during the cold season in the Gulf of Mexico, especially when there is a vigorous high pressure area to the northeast, are producers of copious precipitation in Georgia. The V-shaped depression also frequently is attended by heavy rains when it moves across the State. Very heavy rains fell in Georgia during March 13–15, 1913, in connection with a storm of this type. Similarly, a trough of low pressure moving across the country, especially when there is a secondary development in the southern part of the trough, gives generous rains over much of the State. The rains of December 14 and 28–29, 1901, over much of the northern half of the State were the result of developments of this character. Sometimes a strong, well rounded cyclonic area appears over the northern Rocky Mountains and, in its eastward progress develops one or more secondary depressions well to the south of the primary one. A storm of this type produced the remarkably heavy rains of March 13–15, 1929, which resulted in either the highest or second highest river stages on record in the Chattahoochee, Flint, and Apalachicola Rivers from West Point and Montezuma, Ga., down to Blountstown, Fla.

The writer has observed in practically all instances of heavy rains in Georgia referred to in the preceding paragraph that there was a high pressure area to the east or northeast of the trough or depression. This arrangement of pressure provides a strong inflow of air over Georgia with the high vapor content necessary to produce heavy precipitation as the disturbance advances over the State.

The really heavy rains (5 inches or more within 24 hours) occur most frequently during July to October, when they are due either to convection or to the visitation of tropical cyclones, and again during the cold months, especially in February and March, when they are the result largely of extra-tropical cyclones passing over or near Georgia.[2]

The rains of outstanding magnitude, as a rule, have been those due to tropical storms, but those accompanying extra-tropical storms sometimes are not far behind, a noteworthy instance being the occurrence of 10.88 inches of rain at Blakely, Ga., on March 15, 1929. Further information on the seasonal distribution of heavy rains is contained in the following table which shows the greatest number of stations by months with prolonged heavy rains of 5 inches or more in 2 days and, for longer periods, at least 3 inches more than the number of days.

Month	Greatest number	Year	Month	Greatest number	Year
January	26	1925	July	34	1916
February	13	1929	August	14	1928
March	25	1929	September	19	1929
April	7	1912	October	19	1929
May	2	1901, 1903	November	4	1906
June	6	1902	December	21	1919

The year 1929 stands out as the year with the most frequent heavy rains.

[2] See preceding paper by Mindling.

REMARKS ON THE THEORY OF THE PSYCHROMETER

By W. J. HUMPHREYS

[Weather Bureau, Washington, November 1933]

The validity of the classical theory of the psychrometer is now and again questioned and a substitute offered that is far more elaborate than that which hitherto has been considered adequate. As the older theory is very simple, and also, some of us hold, entirely sufficient, it may be worth while to tell it again, with a little variation, perhaps, in the interest of simplicity and clearness.

The psychrometer, an instrument used for determining the humidity of the air, consists, in part, of an adequately ventilated thermometer whose bulb and adjacent portion of the stem are covered with a closely fitting jacket, commonly of clean, unstarched muslin, that is kept fully wet with pure water, but generally not dripping. Its gain of heat through conduction along the stem and by radiation are negligible in comparison with that by contact with the free air (made so by construction and manipulation), or approximately known and allowed for. In short, such gains of heat by the wet-bulb thermometer may be regarded as zero, since with a good instrument properly used they are, for most purposes, negligibly small, and since, whenever necessary, their values can be determined fairly closely and applied as corrections.

In many psychrometers one side of the wet bulb continuously faces the ventilating and more or less smoothly flowing current while the other side is exposed to the turbulent wake in this current produced by the obstructing instrument. This irregularity must, it would seem, affect the temperature of the wet bulb, but experiment

shows that the extent to which it is thus affected is imperceptible when the ventilation is vigorous. Besides, the psychrometer can be so constructed and operated that all parts of the wet bulb are equally and abundantly ventilated.

It will be assumed, therefore, that the wet bulb is uniformly ventilated all over and that we have only to consider its loss of heat through evaporation and its simultaneous gain of heat through contact with the surrounding air. Obviously, these two quantities, heat loss and heat gain per minute, say, or other time interval, are equal when the temperature of the wet bulb remains constant.

Under the above restrictions as to radiation and stem conduction it is clear that heat can be given to the wet bulb by the warmer surrounding air only by conduction (in this case molecular diffusion) or convection (mass diffusion). In both cases the transfer of heat is by contact, and the only difference is in the rate of action. In general convection is much speedier than diffusion.

When a steady state is reached it may be assumed that the shell of air of exceedingly minute thickness, one thousandth of an inch, say (much thinner, if we wish, as that still is 100 times the molecular free path in air of sea-level pressure and room temperature), has the temperature of the wet bulb, and that the space occupied by this shell is saturated with water vapor, of course at this same temperature. Accordingly there always is a vapor pressure gradient to or from the wet bulb, except when the space round about is saturated with water vapor, in which case the temperature of the wet bulb is the same as that of the free air. Let there be a vapor-pressure gradient outward, as usually is the case. There then will be a continuous flow of vapor out from the space in question, tending to reduce its humidity to below saturation and an equally rapid evaporation to maintain saturation, which evaporation consumes heat and tends to lower the temperature of the wet bulb. Thus where there is a vapor gradient outward there is a temperature gradient inward. Also experiment shows that, under the given conditions, the temperature of the wet bulb soon comes to a constant value, more or less below that of the free air. That means that the supply of heat to it from this warmer air, no matter how it arrives, is at exactly the same rate as the loss of heat by evaporation. In other words, the net loss or gain of heat by the wet bulb is zero, and therefore its temperature remains unchanged.

Let, then, the net evaporation (evaporation minus condensation) of water from the wet bulb in a given interval during the time of the "steady state" be n molecules. The heat thus lost is given by the equation

$$Q=nw'L_{t'}$$

where w' is the mass of a molecule of water vapor and $L_{t'}$ the latent heat of vaporization at the temperature t' of the wet bulb.

As explained, exactly this same amount of heat must somehow be supplied to the wet bulb from the free air whose higher temperature is t. This could be supplied by the cooling of a certain number N of the air molecules from their initial temperature t to that of the wet bulb, t', or, in symbols,

$$Q=Nws(t-t')$$

where w is the equivalent mass per molecule of the free air mixture of gases (mass of a given volume of this air divided by the number of molecules in that volume) and s the specific heat of this mixture.

From these two equations we get

$$n=\frac{Ns(t-t')}{\frac{w'}{w}L_{t'}} \tag{1}$$

As previously stated, all the cooling obviously is at the surface of the wet bulb by the evaporation, in a given time, of n molecules of water, and all the sustaining, incoming heat delivered also at this surface in amount equal, in the same time, to the cooling of N molecules of the free air from its temperature t to t', or would be if the supply of heat to the wet bulb were direct from the free air as here indicated. If this supply of heat is not direct it then must be through a step by step process in which some of the outer air is cooled by a less amount than $t-t'$, while the colder air that gains this heat is warmed to a correspondingly higher temperature, and thus rendered more effective in its transmission in turn of heat towards, or to, the wet bulb. Presumably, therefore, the final result would be the same in either case however different the times of its attainment. And this conclusion is supported by the fact that the end temperature of the wet bulb is the same for all degrees or speeds of ventilation so far tested (a wide range), when radiation and other disturbing factors, here supposed absent, are excluded or properly allowed for.

Also, when the temperature and pressure are constant, every small volume of the gas adjacent to the wet bulb that is torn away is replaced by an exactly equal volume, when at the same temperature, of the free air. And as the cooling is by the evaporation of the extra water molecules thus removed while the heating is by the warmer air simultaneously brought in, it follows that, for any particular temperature, t', say, the number, n', of molecules of evaporated water in this minute volume of evicted saturated air is given by the equation

$$n'=k\frac{e''}{B},$$

and the number, N', of those of the substituted free air by the equation

$$N'=k\frac{B-e''}{B}$$

where B is the total barometric pressure, e'' the pressure due to the freshly evaporated water, and k the number of gas molecules per volume equal to that under consideration at the temperature t' and pressure B. But when the temperature and pressure are constant the value of k is the same for all gases and mixtures of gases, hence it has the same value in the above equations.

Furthermore, since these equations apply to each and every exchange between the cooler saturated air adjacent to the wet bulb and the warmer free air, it follows that they hold also for our original n and N, that is, the total number, respectively, of the evaporated water molecules evicted from around the wet bulb in a given interval of time and of the free air molecules simultaneously brought in and by which the steady temperature of the wet bulb is maintained. Therefore, substituting our original n and N for the n' and N' in the above equations, dividing one by the other, and noting that the value of k is the same in each, we get

$$n=N\frac{e''}{B}\left[1+\frac{e''}{B}+\left(\frac{e''}{B}\right)^2+\text{------}\right]$$

$$=N\frac{e''}{B}D$$

Substituting in (1), we have

$$e''=\frac{Bs(t-t')}{\frac{w'}{w}DL_{t'}}$$

But $e''=e'-e$
where e' is the vapor pressure corresponding to saturation at the temperature t' and e the vapor pressure of the free air, the thing we are trying to evaluate.

Therefore

$$e=e'-\frac{Bs(t-t')}{\frac{w'}{w}DL_{t'}}$$

But as e is only a small fraction of B it follows that s is nearly the same as the specific heat, and w' approximately the equivalent molecular weight, of absolutely dry air and D a number but little greater than unity. We may therefore assume these limiting values for s, w' and D, and obtain the first approximation to the value of e. We then can correspondingly correct s, w' and D and find a closer value of e, and so on as far as we wish to go. Usually, however, the first approximation to the value of e is (theoretically) correct to less than 1 percent.

Therefore, closely enough for most purposes,

$$e=e'-AB(t-t')$$

where A is a numerical constant, of one value when the wet bulb is covered with liquid water and another when the coating is ice.

THE COLD POLE OF SOUTH AMERICA

By JULIO BUSTOS NAVARRETE, Director

[Observatorio del Salto, Santiago, Chile, October 1933]

(Translated by W. W. Reed)

On account of its geographic configuration, being surrounded by great oceans, South America does not offer conditions favorable for the occurrence of intensely cold weather such as is experienced in Siberia and North America. Nevertheless, the investigations made during 14 years by the Observatorio del Salto have shown that in South America, as in other regions, there exists a cold pole, which is well defined and from which there radiate cold waves every winter.

One naturally would suppose that the most intensely cold weather in South America occurs in Magallanes, the most southerly portion of the continent, but this is not the case. The observations made during many years at stations in Chile and Argentina have shown that the most intense cold occurs in a small zone situated in the interior of the continent, the region limited by the stations of Chos Malal, Lonquimay, Las Lajas, and Bariloche.

The occurrences of very low temperatures are always accompanied by mighty invasions of polar air loosed from the Antarctic front. These enormous air masses, indicated on the meteorological charts by anticyclonic systems of high pressure, often enter the continent between latitudes 40° and 50° S., lingering at times in the region of Aysen, Chiloe, and Llanquihue on account of the natural resistance offered to their advance by the cordillera of the Andes.

Under these conditions the anticyclonic centers usually remain for several days or even weeks over southern Chile, bringing generally fine weather with south or southwest winds, which keep the air clear during the long winter nights. Such meteorological conditions are extraordinarily favorable to rapid loss of heat at night by radiation. The land quickly loses its accumulated heat and for several consecutive nights the minimum temperatures in the open fall gradually and progressively. The masses of cold polar air and their calm and transparency during the long winter nights all favor the loss of heat from the earth. The snow is changed into compact ice, which the feeble rays of the sun of the next day are unable to melt. Hence it accumulates, layer upon layer, after each nocturnal freezing brought by an invasion of polar air.

For these reasons there have occurred in the region bounded by Chos Malal, Las Lajas, Lonquimay, and Bariloche minimum temperatures of −32° C. in standard shelters and −40° C. in the open with clear sky. This zone constitutes what is known as the cold pole of South America, and from this region there radiate the cold waves that in severe winters often invade the central valley of Chile and the pampas of Argentina.

As the cold pole in our hemisphere is always situated northeast of the center of high atmospheric pressure, or anticyclone, the diverging waves of icy air spread low temperatures to the remainder of the southern part of the continent. On the meteorological charts of South America it is possible to follow, day by day, the advance of these waves of cold air that moderate little by little until they reach the equatorial regions.

AN AID IN LOCATING AND STUDYING CLOUDS

By IRVING F. HAND

[Weather Bureau, Washington, November 1933]

In studies of solar radiation, it often is essential to know whether the ever-present haze is without form, or owing in part to definite clouds. A Nicol prism mounted at the eye end of a tube (the latter to cut off extraneous light) is not only of great help in locating clouds of indefinite form, but also resolves details of an intricate kind that ordinarily would remain undetected.

The writer recently made a simple instrument of this nature and tested it with the aid of several casual observers. Filters of various colors were tried in the optical train and while theoretically red should give the best results, the consensus of opinion was that the instrument worked better without any filter. In several instances clouds were rendered visible within the area of maximum polarization that could not be seen with the naked eye.

This "cloud finder" has its limitations as shown by the theory of skylight polarization. Generally speaking, maximum polarization occurs in a plane at right angles to the direction of the incident solar rays, but the percentage decreases as we get away from a point 90° from the sun. Thus with the sun on the horizon the maximum polarization occurs in the zenith. At that point it is plane-polarized vertically, while on the horizon at right angles to the sun's direction, that is, to the north

or south at the time of the equinoxes, the skylight is plane polarized horizontally. Between the zenith and the horizon it is plane polarized at varying angles, except at two points which range from 15° to 25° above the horizon where the polarization is zero.

Therefore at noon during the summer season, the amount of polarization near the horizon to the west enables one to isolate from the haze incipient thunderheads considerably in advance of their detection with the naked eye. Near the sun, where polarization is slight and the diffused light intense, clouds are better detected with a dense red filter than with a Nicol prism.

In practice one does not *compute* the angle of polarization, but merely adjusts the Nicol by orientation until the sky appears darkest at which point the *plane* of the Nicol is at right angles to the plane of polarization. Through a perfect Nicol a cloud in a sky 100 percent polarized would appear snow-white against a jet-black background. Such contrasts never occur in nature, however, as the percentage of skylight polarization rarely exceeds 80. As even the inconsiderable amount of polarized light from the cloud is chiefly elliptical, the Nicol is of little use as an analyzer of its illumination.

SUPERSATURATION AGAIN

By W. J. Humphreys

[Weather Bureau, Washington, November 1933]

Most of us well may wonder whether the persistent idea that a fourfold supersaturation can and does occur in the air is Truth, for crushed to earth it rises again, or a Hydra which every time its head is cut off sprouts two new ones in its stead. At any rate it keeps bobbing up here, there, and yonder, even in scientific literature—in the offhand explanation of a cloudburst (excessively heavy local rain), perhaps; the boiling of a large cumulus, or cumulonimbus, cloud; or some other such meteorological phenomenon which the author has not taken the trouble to understand.

By saturation is meant that degree of humidity, or mass of water vapor per unit volume (vapor density), that is, or would be, in equilibrium with a flat surface of pure water at the same temperature. Supersaturation is any higher degree of humidity, or greater vapor density, than that of saturation. Now from observation, and by experiment, we know that in ordinary air condensation, producing a fog of water droplets, starts when the humidity is in the neighborhood of saturation—more or less short of saturation when the condensation nuclei are particles of sea salt or other hygroscropic substance, and slightly beyond, perhaps, when they are nonhygroscopic. In well-filtered air, on the contrary, condensation does not begin until at least a fourfold supersaturation is attained and then only on such negative ions as may be present. A much greater supersaturation is necessary to cause condensation on positive ions, and a greater still in the case of neutral molecules. Therefore, in order that any considerable degree of supersaturation may occur in the atmosphere it must be freed from all ordinary condensation nuclei.

Our discussion, therefor, may be divided into two distinct parts—(1) a consideration of whether any large volume of the troposphere, or rainy region of the atmosphere, can be freed of condensation nuclei; and (2) what would happen if condensation should occur in a fourfold supersaturated space of considerable size. We need not concern ourselves about providing negative ions—they appear to be always and everywhere in the atmosphere.

Is, then, any considerable volume of the troposphere ever free from condensation nuclei? This much we can say: All the innumerable examinations for such nuclei, under various weather conditions and at many different levels, showed them to be present in great abundance. To be sure we can free a small volume of air from nuclei by filtering it, for example, through a tube filled with raw cotton, glass wool, or other finely divided suitable substance; and by inducing repeated condensations in it by expansions, say in a bell jar containing some water, and allowing the droplets to settle out carrying the nuclei with them. But the free air is not operated on very completely in either of these ways. The nearest approach to exhaustion of these nuclei in the open air presumably occurs in the midst of a large nimbus or cumulo-nimbus cloud. Here the ascending nucleus-laden air is partially filtered as it rises through the cloud, and partially cleaned by progressive condensation. Even if the air within any portion of the cumulus were freed from all nuclei there still would be droplets, or snow crystals, falling through it from its outer shell, as it were, which is in contact with unfreed air, and any considerable supersaturation thus prevented. And, of course, it could not pass out through this wall of dense cloud, every droplet of which is an efficient condensation nucleus, and still remain appreciably supersaturated. Presumably, therefore, marked supersaturation does not occur in the open atmosphere.

However, let us assume that sometimes a considerable volume of the air is cleared of all ordinary condensation nuclei, and that supersaturation has progressed to the fourfold value, at which stage condensation begins on the ever present negative ions. What would happen?

Condensation once begun would progress with great rapidity on the droplets thus formed until the vapor density had fallen to normal saturation. The freed heat of vaporization would increase the temperature of the air, expand it and induce convection, which in turn would cause the condensation of more vapor and further convection to a great but determinate height. Here a little calculation will be helpful, and rough approximations will suffice.

Let, then, the temperature of the air be 25° C., or 298° absolute, and the saturation fourfold, and let condensation start at this stage.

According to humidity tables the initial vapor density would be 91 grams per cubic meter. Density of the air, 1,200 grams per cubic meter, roughly. Specific heat of air at constant pressure, allowing for the water vapor present, 0.25, approximately. Latent heat of vaporization, say 600 calories per gram.

Hence to warm the 1,200 grams of air 1° C. would require 300 calories, which could be supplied by the condensation of 0.5 gram of vapor. But this warming would expand the air and correspondingly increase the volume to be occupied by the vapor.

Let the initial condensation from a fourfold supersaturation to normal saturation, and the consequent heating and expansion, occur at constant pressure, that is, be complete before convection sets in.

Let x° C. be the increase in temperature and y the grams of vapor condensed. Then

$$x=2y$$

$$\frac{\text{New volume}}{\text{Old volume}}=\frac{298+x}{298}$$

91 = initial grams per cubic meter.

$$\frac{91-\frac{x}{2}}{\frac{298+x}{298}}=\text{final grams of vapor per cubic meter.}$$

We can assume any value we like for x and compute from the last equation the corresponding vapor density. If this value is too great for normal saturation at the absolute temperature $298+x$ then x is too small; and conversely, when the computed value is less than that required for saturation. In this way an approximately correct value of x is readily determined.

It turns out that, under the assumed conditions, namely, fourfold supersaturation at 25° C. $x=22°.5$.

Vapor condensed, $y=\frac{x}{2}=11.25$ grams per initial cubic meter, leaving 79.75 grams per initial cubic meter uncondensed.

Violent convection will occur, owing to the great heating, and continue until very little vapor is left. As a rough approximation let all the water vapor be condensed. The heating would be $x=2y$, but y is 91, the initial grams per cubic meter. Hence $x=182°$ C., and the temperature would be 207° C. This would cause the air to ascend into the stratosphere, and to reach the temperature of this region, say −53° C., the cooling would need to be 260° C., and the ascent, if along the dry adiabat, 26 kilometers. Actually the condensation and resulting cumulus cloud would be all along the route of ascent.

But cumulus clouds of such great heights have never been observed.

The conclusions are:

1. It does not appear possible for any appreciable supersaturation to occur in the atmosphere, much less a fourfold supersaturation that would be necessary to condensation on negative ions.

2. The inevitable consequences of such a supersaturation are not known to occur.

Presumably, therefore, such supersaturation does not and cannot occur in the free air. Presumably also the unwarranted assumption that it does so occur still has a long lease of life in our scientific literature and even immortality in popular writings.

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SOLAR OBSERVATIONS

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1932, REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged above normal for October at all three Weather Bureau stations.

Table 2 shows an excess in the total solar radiation received on a horizontal surface at all stations for which normals have been computed, with the exception of Twin Falls and Miami.

Since the installation of a new blast furance by the Research Corporation on the campus of the American University, smoke and gases have at times so vitiated the atmosphere as seriously to interfere with normal-incidence measurements, as shown in table 3.

Polarization measurements made on 5 days at Washington give a mean of 59 percent with a maximum of 63 percent on the 10th. At Madison, measurements made on 6 days give a mean of 69 percent with a mximum of 76 percent on the 2d. These values are slightly higher than the October normals at both stations.

TABLE 1.—*Solar radiation intensities during October, 1933*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D.C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A.M.					Air mass P.M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0 [1]	2.0	3.0	4.0	5.0	e.
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
Oct. 2	8.48	0.75	1.00	1.15	1.27		1.26				7.57
Oct. 5	10.59		.44								9.83
Oct. 6	7.57	.91	1.03	1.16	1.31	1.49	1.33	1.11	1.00	0.87	6.76
Oct. 7	6.76	.73	.94	1.02	1.18	1.44					8.18
Oct. 10	7.87	.68	.83	.99	1.10						6.02
Oct. 12	8.18				1.04						10.59
Oct. 14	6.02		.96	.99							4.17
Oct. 19	6.02			1.10							4.95
Oct. 20	6.27				1.06						8.18
Oct. 26	2.74	.94	1.05	1.12	1.30		1.16	1.02			3.30
Oct. 27	4.75						1.12	.98			6.27
Oct. 30	6.27	.44	.66	.85							9.73
Oct. 31	8.48	.56	.64	.82	1.04						10.97
Means		.72	.84	1.02	1.16	(1.46)	1.22	1.04	(1.00)	(.87)	
Departures		−.03	±.00	+.06	+.04	+.05	+.09	+.10	+.19	+.15	

MADISON WIS.

Date	8 a.m. e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	Noon e.
Oct. 2	5.16		0.99	1.18	1.33	1.52					4.95
Oct. 3	5.56		.88								6.27
Oct. 4	7.04				1.23						7.29
Oct. 5	6.50		.83		1.21	1.52					7.04
Oct. 11	7.29			1.07			1.27				7.29
Oct. 12	5.36	.98	1.08	1.20							4.17
Oct. 13	4.57	.86	.94								4.37
Oct. 18	4.57				1.34	1.54					3.30
Oct. 25	2.74	1.06	1.11	1.18							2.87
Oct. 30	9.47		.68	.89	1.08		1.10				11.38
Oct. 31	10.21	.66	.79	.87	1.12		1.13				11.81
Means		.89	.91	1.06	1.22	1.53	1.17				
Departures		+.11	−.01	+.02	+.03	+.09	−.02				

[1] Interpolated.

TABLE 1.—*Solar radiation intensities during Otcober, 1933*—Con.

LINCOLN, NEBR.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A.M.					Air mass P.M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e.
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
Oct. 1	5.79					1.54	1.32	1.14	1.03	0.93	4.17
Oct. 2	5 36		1.06	1.23	1.35	1.46					4.57
Oct. 4	7.57	0 87	.98	1.10	1.28	1.39	1.29	1.14	1.00	.88	6.76
Oct. 5	5.79	.76	.84	1.04	1.28	1.49	1.26	1.07	.92	.82	7.29
Oct. 6	6.50	.84	.98	1.10	1.29	1.54					4.75
Oct. 7	4.37	.98	1.06	1.20	1.36	1.59					4.17
Oct. 9	4.37	.67	.82	.87	1.19	1.52	1.34	1.16	1.07	.96	5.16
Oct. 10	5.16					1.51	1.23	1.00	.90	.82	6.76
Oct. 11	6.27	.71	.85	1.01	1.20	1.40					5.36
Oct. 12	4.17		.92	1.05	1.38						4.75
Oct. 13	4.17		.94		1.30	1.46	1.20	1.01	.85	.73	5.36
Oct. 16	5.36		1.11	1.24							4.57
Oct. 26	4.96								1.00	.90	5.16
Oct. 28	6.76	.70	.88	1.03	1.18						7.57
Oct. 29	4.75						1.18	1.01	.86	.75	10.21
Oct. 30	10.59	.70	.82	.98	1.14		1.15	.94	.80	.70	10.59
Oct. 31	11.35		.85	1.01	1.21						11.38
Means		.78	.93	1.08	1.26	1.49	1.25	1.06	.94	.83	
Departures		−.06	−.01	−.02	−.02	+.01	+.00	−.02	−.01	−.01	

BLUE HILL, MASS.

Date	8 a.m. e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	Noon e.
Oct. 2	9.8						1.15	1.02			9.0
Oct. 3	6.3				1.10						5.7
Oct. 6	9.5							.97			8.3
Oct. 8	7.9			1.24	1.40		1.26	1.14	1.00		7.1
Oct. 10	9.1			1.01	1.22		1.20			0.68	5.4
Oct. 11	7.3				1.27						6.9
Oct. 12	9.5			1.00	1.09		1.02	.83			9.5
Oct. 14	4.4				1.33		1.37	1.28	1.19		4.1
Oct. 15	4.4			1.19	1.29		1.26	1.05	.91	.79	4.0
Oct. 16	7.0						1.28	1.11	.97	.85	6.8
Oct. 18	5.8				1.23						3.3
Oct. 19	4.6				1.35		1.21	.74			3.0
Oct. 21	4.4				1.30						5.5
Oct. 25	5.0			1.16							2.9
Oct. 26	2.7				1.38		1.37	1.11	1.01		1.7
Oct. 29	3.7				1.37						1.7
Oct. 30	3.4			1.17	1.17			.94	.77		4 7
Oct. 31	5.0			.81	.89		.82	.49			7.5
Means				1.08	1.24		1.19	.97	.68	.77	

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Gram calories per square centimeter

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans	Riverside	Blue Hill
1933	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Oct. 1	382	353	432	344	327	437	242	138	438	308	330	324	404	439	259
Oct. 8	343	266	388	286	299	407	206	102	398	196	....	452	409	349	327
Oct. 15	292	196	306	167	250	417	230	86	346	382	317	360	250	411	325
Oct. 22	257	185	324	158	199	389	172	89	274	220	260	372	328	329	189
	Departures from weekly normals														
Oct. 1	+50	+80	+102	+114	+47	+10	−16	....	+22	+14	−27	−156	....	....	....
Oct. 8	+35	+23	+83	+83	+51	+56	−10	....	+17	−78	....	+50	....	....	....
Oct. 15	+14	−26	−1	−15	+36	+40	+36	....	−12	+115	−52	−23	....	....	....
Oct. 22	−10	−16	+49	−3	+7	+19	−9	....	−41	−48	−79	+3	....	....	....
	Accumulated departures on Oct. 29														
	+7,567	−1,442	+5,516	+13,650	+9,086	+9,590	−1,659	....	+609	+9,247	....	−4,984	....	....	....

TABLE 3.—*Solar radiation measurements, and determinations of atmospheric-turbidity factor, β, Washington, D.C., October 1933*

[Values in italics have been interpolated]

Date and solar-hour angle	Solar altitude, *h*	Air mass, *m*	I_m	I_y	I_r	β	Blueness of sky	Atmospheric dust particles per cubic centimeter	Notes: Skylight polarization, P., clouds, etc.
Oct. 3									
				gr. cal.	*gr. cal.*	*gr. cal.*			
4:32a	14–20	4.00	1.005	*0.792*	0.645	0.035	......	548	
4:27a	15–16	3.74	1.038	.796	*.647*	.045			
4:09a	18–34	3.12	1.107	.739	*.691*	.060			
4:04a	19–28	3.02	1.137	*.741*	.691	.055			
3:51a	21–25	2.72	1.190	*.779*	.715	.055			
3:46a	22–40	2.58	1.208	.782	*.718*	.055			
3:00a	30–22	1.98	1.270	.927	*.738*	.070			
2:55a	31–10	1.93	1.306	*.930*	.743	.060			
Oct. 6									
4:24a	15–00	3.82	1.053	*.800*	.655	.040	......	855	
4:18a	16–06	3.57	1.083	.803	*.658*	.040			
3:53a	20–35	2.82	1.190	.867	*.709*	.045			
3:46a	21–49	2.69	1.198	*.870*	.712	.055			
2:56a	30–06	2.00	1.312	*.952*	.749	.055	6	....	P=60.4%
2:52a	30–43	1.95	1.342	.955	*.752*	.045			
1:48a	39–42	1.57	1.407	.991	*.786*	.090			
1:43a	39–58	1.57	1.380	*.994*	.791	.080			
0:26a	45–34	1.40	1.372	*.999*	.791	.090			
0:20a	45–43	1.39	1.392	1.000	*.794*	.090			
Oct. 7									
4:31a	13–29	4.24	.934	*.747*	.597	.060			
4:24a	14–46	3.87	.957	.750	*.600*	.065			
4:15a	16–24	3.51	1.014	.770	*.636*	.065	......	1,367	
4:11a	17–06	3.37	1.045	*.773*	.639	.055			
3:55a	19–58	2.90	.996	*.787*	.649	.095			
3:50a	20–50	2.80	1.090	.740	*.652*	.065			
2:57a	29–38	2.02	1.198	.895	*.633*	.045			
2:50a	30–46	1.95	1.187	.900	*.636*	.055			
2:01a	37–29	1.64	1.309	*.885*	.749	.085			
0:17a	45–18	1.41	1.106	*.890*	.773	.290			
0:11a	45–38	1.40	1.096	.894	*.779*	.300			
Oct. 10									
4:36a	11–46	4.80	.673	*.658*	.547	.180	......	284	
4:31a	12–41	4.47	.751	.661	*.549*	.120			
4:04a	17–34	3.30	.940	.736	*.615*	.160			
4:00a	18–16	3.17	.966	*.741*	.618	.090			
3:15a	29–28	2.02	1.119	*.835*	.688	.110			
3:11a	29–47	2.01	1.070	.839	*.691*	.145	6	....	P=62.9%
Oct. 26									
2:56a	24–59	2.37	1.288	*.949*	.780	.060			
2:50a	25–53	2.29	1.294	.952	*.782*	.065	6	....	P=59.7%
1:04a	37–28	1.64	1.088	.784	*.639*	.140			
1:00a	37–43	1.63	1.091	*.788*	.642	.140			
2:57p	24–47	2.36	1.080	*.814*	.658	.090			
3:04p	23–50	2.46	1.108	.818	*.661*	.080			
3:31p	19–40	2.96	1.035	.782	*.644*	.070			
3:35p	19–00	3.06	.987	*.788*	.642	.080			

TABLE 4.—*Summary of solar radiation intensity measurements made at the Blue Hill Meteorological Observatory, Milton, Mass., during October 1933*

[I_m=total intensity; I_r=that transmitted by *red* filter; I_y=that by yellow filter]

Date and hour angle from solar noon	Solar altitude, *h*	Air mass, *m*	I_m	I_y	I_r	Sky conditions; clouds, haze (hz), smoke (smk), visibility (v), wind
Oct. 2	° '		*gr. cal.*	*gr. cal.*	*gr. cal.*	
2:10, p.m.	35 33	1.72	1.161	0.837	0.662	
4:04, p.m.	18 26	3.11	1.001	.792	.590	Few Cist, 3 Cu; v 2; E-2.
Oct. 3						
2:48, a.m.	30 09	1.99	1.210	.886	.720	5 Ci; v 7; NE-5.
1:10, a.m.	41 08	1.52	1.341	.972	.734	3 Ci, few Cu; v 8-9; NE-5.
0:33, p.m.	43 11	1.46	1.350	.958	.734	3 Ci, Cist; v 8-9; NNE-5.
Oct. 8						
3:04, a.m.	18 24	3.14	1.292	.936	.734	
1:09, a.m.	39 24	1.57	1.390	.940	.765	1 Acu, Cu; v 9; W-4.
0:19, p.m.	41 41	1.50	1.380	.963	.738	Few Acu, Cu; v 9; W-4.
2:24, p.m.	31 48	1.89	1.316	.927	.724	
2:50, p.m.	28 08	2.12	1.246	.900	.700	Few Acu, Frcu; v 9; W-3.
Oct. 10						
2:41, a.m.	28 55	2.06	1.202	.904	.727	Few Acu; v 6-7; W-5.
1:13, a.m.	38 16	1.61	1.287	.945	.742	Few Ci, Cicu; v 7; W-5.
0:28, p.m.	40 43	1.53	1.292	.940	.747	Few Frcu; v 8-9; WSW-5.
3:00, p.m.	26 14	2.26	1.048	.788	.630	Few Cu, Frcu; v 8; W-6.
Oct. 11						
2:42, a.m.	28 30	2.09	1.238	.904	.724	2 Ci; v 7-8; W-4.
Oct. 12						
2:44, a.m.	27 54	2.13	1.084	.806	.652	No clouds; v 7; SSW-6.
2:52, p.m.	26 47	2.21	.909	.684	.536	1 Ci near sun; few Cu; v 7; WSW-6.
Oct. 14						
2:42, a.m.	27 32	2.16	1.264	.945	.752	Few Acu, Frcu, Cu; v 9; NW-4.
0:27, a.m.	39 15	1.58	1.412	.986	.774	Few Ci, Cicu; v 9; NW-4.
1:01, p.m.	37 43	1.63	1.395	1.012	.781	Few Ci, Cicu; v 0; NW-4.
2:30, p.m.	29 05	2.06	1.354	.968	.776	1 Ci; v 9; WNW-4.
Oct. 15						
2:25 a.m.	29 08	2.06	1.292	0.950	0.752	0 clouds; v 6-8; W-3.
0:10 a.m.	39 12	1.58	1.364	.954	.752	0 clouds; v 7-8; W-2.
1:26 p.m.	35 32	1.72	1.316	.954	.747	0 clouds; v 8; SW-3.
2:51 p.m.	26 00	2.28	1.190	.889	.675	0 clouds; v 8; SW-2.
Oct. 16						
1:07 a.m.	36 42	1.67	1.382	.994	.776	0 clouds; v 8; S-5.
Oct. 18						
2:32 a.m.	27 36	2.15	1.220	.904	.724	1 Cist; smk or hz; v 6-7; W-3.
0:52 a.m.	36 50	1.67	1.206	.878	.698	
0:03 a.m.	38 09	1.62	1.260	.918	.729	1 Cist over sun; 1 Cu; v 8; W-4.
Oct. 19						
2:42 a.m.	25 58	2.28	1.305	.963	.774	Few Ci, Cist over sun; v 9; NW-5.
1:00 a.m.	36 00	1.70	1.404	.976	.780	
1:17 p.m.	34 53	1.78	1.377	.994	.788	2 Cist, Ci; v 9+; WNW-1.

TABLE 4.—*Summary of solar radiation intensity measurements made at the Blue Hill Meteorological Observatory, Milton, Mass., during October 1933*—Continued

[I_m=total intensity; I_r=that transmitted by *red* filter; I_y=that by yellow filter]

Date and hour angle from solar noon	Solar altitude, *h*.		Air mass, *m*.	I_m	I_y	I_r	Sky conditions; clouds, haze (hz), smoke (smk), visibility (v), wind
Oct. 21	°	′		*gr. cal.*	*gr. cal.*	*gr. cal.*	
2:28 a.m.	27	10	2.18	1.260	.927	.752	2 Ci, Cist, Cicu, few Frcu; v 6; NE-3.
Oct. 26							
2:32 a.m.	25	07	2.35	1.292	.968	.774	0 clouds; v 9; WNW-5.
1:21 a.m.	31	50	1.89	1.382	.992	.796	
0:23 a.m.	35	04	1.74	1.418	1.022	.824	0 clouds; v 8-9; NW-3.
2:53 p.m.	22	25	1.61	1.215	.886	.722	Few Cist; v 8-9; N-3.
Oct. 29							
2:28 a.m.	24	44	2.38	1.350	1.035	.817	Few Stcu; v 9-10; NNW-3.
0:07 p.m.	34	45	1.75	1.361	.968	.765	Few Ci; v 9; NW-3.
Oct. 30							
2:33 a.m.	24	02	2.45	1.048	.792	.650	
1:10 a.m.	31	43	1.90	1.197	.846	.684	1 Ci, 2 Cist; hz over sun; v 6-7; N-4.
Oct. 31							
1:05 a.m.	31	40	1.90	.904	.684	.549	Hz over sun; v 6; SW-2.
2:58 p.m.	20	24	2.85	.626	.503	.405	Few Ci; dense hz; v 6; WSW-2.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent United States Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Perkins, and Mount Wilson observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time		Heliographic			Area		Total area for each day
			Diff. long.	Longitude	Latitude	Spot	Group	
1933	*h*	*m*	°	°	°			
Oct. 1 (Naval Observatory)	12	2		No spots				
Oct. 2 (Naval Observatory)	13	7		No spots				
Oct. 3 (Naval Observatory)	11	48		No spots				
Oct. 4 (Mount Wilson)	9	48		No spots				
Oct. 5 (Naval Observatory)	14	24		No spots				
Oct. 6 (Naval Observatory)	11	9		No spots				
Oct. 7 (Naval Observatory)	11	0		No spots				
Oct. 8 (Naval Observatory)	13	50		No spots				
Oct. 9 (Naval Observatory)	11	12		No spots				
Oct. 10 (Naval Observatory)	11	10		No spots				
Oct. 11 (Naval Observatory)	11	49		No spots				
Oct. 12 (Naval Observatory)	12	16		No spots				
Oct. 13 (Mount Wilson)	11	20		No spots				
Oct. 14 (Naval Observatory)	11	41		No spots				
Oct. 15 (Naval Observatory)	11	42		No spots				
Oct. 16 (Naval Observatory)	12	23		No spots				
Oct. 17 (Naval Observatory)	12	14		No spots				
Oct. 18 (Naval Observatory)	12	9		No spots				
Oct. 19 (Naval Observatory)	10	30		No spots				
Oct. 20 (Naval Observatory)	13	14		No spots				
Oct. 21 (Naval Observatory)	12	11		No spots				
Oct. 22 (Naval Observatory)	11	38		No spots				
Oct. 23 (Mount Wilson	9	50		No spots				
Oct. 24 (Mount Wilson)	9	50		No spots				
Oct. 25 (Naval Observatory)	11	51		No spots				
Oct. 26 (Naval Observatory)	12	27	−2.0	89.5	+8.5		123	123
Oct. 27 (Naval Observatory)	12	12	+12.0	90.4	+9.0		93	93
Oct. 28 (Naval Observatory)	10	54	+25.0	91.0	+9.0		93	93
Oct. 29 (Naval Observatory)	10	57	+38.0	90.7	+9.0		93	93
Oct. 30 (Naval Observatory)	12	19	+52.0	90.8	+8.0		62	62
Oct. 31 (Naval Observatory)	12	5	+66.0	91.7	+7.5		46	46
Mean daily area for October								16

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR OCTOBER 1933

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgenössiche Sternwarte, Zurich, Switzerland]

October 1933	Relative numbers	October 1933	Relative numbers	October 1933	Relative numbers
1	0	11	0	21	0
2	0	12		22	0
3	0	13		23	0
4	0	14	0	24	0
5	0	15	0	25	0
6	0	16	0	26	*Mc*9
7	0	17	0	27	20
8	0	18	0	28	19
9		19	0	29	14
10	8	20	0	30	14
				31	12

Mean: 28 days=3.4.

Mc=New formation of a center of activity; *M*, in the central zone.

AEROLOGICAL OBSERVATIONS

[Aerological Division, W. R. Gregg, in charge]

By L. T. SAMUELS

There was considerable variation this month in the free-air temperature departures. They were greatest at Pembina (table 1) and negative at all levels, while at Omaha they were positive and of only slightly less magnitude. At the other stations the temperature departures were mostly of small-to-moderate magnitude with the signs varying considerably. Large positive departures occurred in the lower levels at Dallas and in the upper levels at Boston.

In practically all cases the relative humidity departures were of opposite sign to those for temperature except at San Diego, where positive departures for both of these elements prevailed.

Resultant free-air winds for October were close to normal both in direction and velocity at most stations and levels (table 2). Exceptions to this occurred, however, at Pembina and Omaha, referred to above in connection with marked differences in temperature departures. At Pembina the resultant velocities were below normal while at Omaha they exceeded the normal. The resultant directions were normal at both stations.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during October 1933*

TEMPERATURE (°C.)

Altitude (meters) m.s.l.	Boston, Mass.[1] (6 meters)		Cleveland, Ohio[2] (246 meters)		Dallas, Tex.[3] (146 meters)		Norfolk, Va.[4] (3 meters)		Omaha, Nebr.[5] (300 meters)		Pembina, N.Dak.[6] (243 meters)		Pensacola, Fla.[4] (2 meters)		San Diego, Calif.[4] (9 meters)		Washington, D.C.[4] (2 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	10.8	[7]	8.3	[7]	15.6	[7]	14.3	−0.4	6.4	[7]	0.2	[7]	18.6	+0.4	17.2	−2.0	10.3	−2.5
500	8.4	[7]	10.0	[7]	18.8	[7]	13.9	+.3	8.6	[7]	1.8	[7]	18.3	+.6	17.5	−.5	10.7	−1.3
1,000	7.1	+1.4	8.0	−0.6	18.1	+3.0	11.7	+.5	10.8	+1.6	1.4	−3.4	16.4	+.6	20.1	+2.1	9.9	−.2
1,500	5.4	+1.6	5.6	−.7	16.2	+3.1			9.7	+2.0	−.5	−3.6						
2,000	3.9	+1.7	3.3	−.6	13.8	+2.9	8.2	+.8	7.7	+2.2	−2.7	−3.8	10.9	−1.0	16.7	+2.5	6.7	+.6
2,500	2.5	+2.5	1.6	.0	10.7	+2.2			5.7	+2.8	−5.4	−4.1						
3,000	.7	+3.7	−.6	+.2	7.4	+1.3	4.3	+1.1	2.8	+2.6	−7.9	−3.9	5.7	−1.7	9.8	+1.2	3.4	+1.1
4,000	−4.2	+4.5	−5.8	+.1	1.3	+.4			−2.9	+2.1	−12.9	−3.3	.0	−1.9	2.5	+0.7		
5,000	−9.5		−11.7	−.5	−4.9	−1.0			−9.1	+1.8	−19.0	−4.2	−6.5	−2.0	−4.8	+0.3		

RELATIVE HUMIDITY (PERCENT)

Altitude (meters) m.s.l.	Boston, Mass.[1] (6 meters)		Cleveland, Ohio[2] (246 meters)		Dallas, Tex.[3] (146 meters)		Norfolk, Va.[4] (3 meters)		Omaha, Nebr.[5] (300 meters)		Pembina, N.Dak.[6] (243 meters)		Pensacola, Fla.[4] (2 meters)		San Diego, Calif.[4] (9 meters)		Washington, D.C.[4] (2 meters)	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Surface	73	[7]	78	[7]	82	[7]	76	+1	81	[7]	80	[7]	79	0	80	+13	80	+6
500	72	[7]	69	[7]	67	[7]	67	+1	68	[7]	70	[7]	74	+2	74	+11	68	+4
1,000	67	−7	68	+6	61	−3	64	+2	49	−7	62	+3	69	+1	50	+3	60	−1
1,500	64	−5	62	+5	58	0			45	−8	57	+3						
2,000	60	−3	58	+5	55	+3	50	−1	43	−10	56	+5	60	+3	35	+2	50	−6
2,500	55	−5	45	−3	54	+7			41	−11	55	+6						
3,000	50	−15	47	+1	54	+12	34	−5	44	−6	55	+7	52	+4	30	+3	44	0
4,000	47		50	+7	44	+4			42	−4	53	+6	43	+1	29	+4		
5,000	47		44	+12	37	0			43	0	53	+8	41	+1	25	+2		

Times of observations: Weather Bureau, 5 a.m.; Navy, 7 a.m. and M.I.T., 8 a.m. (E.S.T.).

[1] Airplane observations made by Massachusetts Institute of Technology; departures based on normals obtained from kite observations made at Blue Hill Meteorological Observatory.

[2] Temperature departures based on normals determined by extrapolating latitudinally those of Royal Center, Ind., and Due West, S.C. Humidity departures based on normals of Royal Center, Ind.

[3] Temperature departures based on normals determined by interpolating latitudinally those of Groesbeck, Tex., and Broken Arrow, Okla. Humidity departures based on normals of Groesbeck, Tex.

[4] Naval air stations.

[5] Temperature and humidity departures based on normals of Drexel, Nebr.

[6] Temperature departures based on normals determined by extrapolating latitudinally those of Ellendale, N.Dak., and Drexel, Nebr. Humidity departures based on normals of Ellendale, N.Dak.

[7] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot balloon observations made near 7 a.m. (E.S.T.) during October 1933*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m.s.l.	Albuquerque, N. Mex. (1,554 meters)		Atlanta, Ga. (309 meters)		Bismarck N. Dak. (518 meters)		Brownsville, Tex. (7 meters)		Burlington, Vt. (132 meters)		Cheyenne, Wyo. (1,873 meters)		Chicago, Ill. (192 meters)		Cleveland, Ohio (245 meters)		Dallas, Tex. (154 meters)		Havre, Mont. (762 meters)		Jacksonville, Fla. (14 meters)		Key West, Fla. (11 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	7	1.1	21	1.8	310	0.6	358	0.3	200	2.2	279	3.1	225	2.0	210	1.4	135	1.3	261	1.4	360	2.2	41	2.9
500			64	3.8			143	3.2	216	5.2			250	6.1	244	4.2	154	5.4			54	6.2	60	6.1
1,000			79	2.5	282	3.3	139	2.6	243	5.4			261	6.3	259	5.7	195	4.0	253	3.8	77	4.6	76	5.0
1,500			294	1.8	297	5.9	100	1.4	278	5.1			274	7.9	252	7.6	251	2.9	282	6.2	90	2.1	87	3.3
2,000	9	.9	300	3.4	295	6.9	81	1.6	275	6.2	276	4.6	283	8.6	260	8.3	282	3.0	282	6.3	278	1.8	90	1.5
2,500	309	2.7	276	3.6	297	8.6	48	1.7	279	10.1	278	7.5	290	9.8	270	8.4	306	3.5	281	7.8	285	4.0	180	.6
3,000	293	4.1	281	5.8	293	8.3	6	2.5	276	11.0	285	9.9	288	9.5	267	9.8	314	3.7	285	8.9	277	3.9	208	.2
4,000	284	4.5	257	5.1			315	3.0	258	13.0	290	11.1					347	3.0	301	11.8	312	3.7	276	2.1
5,000	280	4.6									301	6.5					264	3.6			292	2.4	290	4.3

Altitude (meters) m.s.l.	Los Angeles, Calif. (217 meters)		Medford, Oreg. (410 meters)		Memphis, Tenn. (83 meters)		New Orleans, La. (2 meters)		Oakland, Calif. (8 meters)		Oklahoma City, Okla. (402 meters)		Omaha, Nebr. (306 meters)		Phoenix, Ariz. (338 meters)		Salt Lake City, Utah (1,294 meters)		Sault Ste. Marie, Mich. (198 meters)		Seattle, Wash. (14 meters)		Washington, D.C. (10 meters)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	318	1.0	171	0.6	25	0.5	39	2.3	210	0.4	151	1.5	173	0.5	91	2.8	155	4.0	228	0.1	138	1.6	329	1.3
500	32	1.0	212	.2	127	1.1	74	5.3	339	2.0	148	2.4	213	1.7	100	3.4			243	2.8	190	2.5	349	3.5
1,000	42	1.2	228	.5	285	1.6	84	3.4	360	3.3	208	5.0	277	4.4	109	1.7			272	6.1	184	2.8	310	4.2
1,500	68	.7	188	1.3	282	3.5	68	2.0	349	2.1	245	4.7	291	5.9	139	.9	163	3.4	269	7.2	217	2.6	290	5.4
2,000	87	2.1	268	2.3	287	4.4	19	2.1	344	1.4	263	5.0	278	7.6	141	.9	206	1.4	275	10.0	243	4.3	289	6.8
2,500	90	3.4	287	3.1	292	5.9	338	2.4	357	1.4	264	4.7	286	9.5	169	1.3	283	2.0	290	9.4	252	5.3	282	8.4
3,000	63	3.3	282	4.4	281	6.0	347	4.3	352	.7	298	4.9	293	10.6	177	1.6	288	3.8			249	9.6	282	9.3
4,000	50	5.4	278	5.7	285	4.6	304	2.1	282	1.7	293	3.8	282	10.0	207	1.1	289	6.7			268	9.7	273	10.2
5,000			273	5.4	262	4.0									298	2.0	298	9.0						

RIVERS AND FLOODS

By RICHMOND T. ZOCH

[River and Flood Division, Montrose W. Hayes, in charge]

Three minor floods occurred in the United States during October, as shown in the accompanying table. No damage was caused by the overflows in the Santee and Rio Grande and only slight damage by that in the Sulphur.

Table of flood stages in October 1933

[All dates are in October]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Santee: Rimini, S.C.	12	4	9	13.5	6
		12	14	12.4	14

Table of flood stages in October, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Red Basin					
Sulphur: Ringo Crossing, Tex.	20	16	17	23.2	17
WEST GULF OF MEXICO DRAINAGE					
Rio Grande:					
Mercedes, Tex.	20	4	8	21.2	6–7
		17	17	20.1	17
Brownsville, Tex.	18	5	8	18.2	5–8

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDonald, in charge]

NORTH ATLANTIC OCEAN

By WILLIS E. HURD

Atmospheric pressure.—Pressure, as a rule, averaged from normal to slightly below in middle and lower latitudes of the North Atlantic during October 1933, as indicated by table 1, with the point of greatest departure, −0.13 inch, occurring at Horta, Azores. As frequently happens, during months of depression of the Atlantic anticyclone, the Icelandic LOW became less intense, with the consequence that the gradient existing between the two areas, in terms of average monthly extremes of pressure, was comparatively small. This month the average pressure at Reykjavik, Iceland, was 0.13 inch above normal, and the average difference in pressure between Reykjavik and Horta was only 0.17 inch. In October 1932 the corresponding difference was 0.67 inch. The highest corrected barometer reading from a ship at sea during October 1933 was 30.54 inches, occurring on the 22d, near 41° N., 67° W., and on the 28th, near 51° N., 31° W. The lowest corrected reading was 28.49 inches, occurring on the 7th, in 42°17′ N., 65°56′ W. A reading of 28.30 inches, but uncorrected, was made on the 6th, in 29°50′ N., 74°50′ W. Both low readings were in connection with the hurricane of October 1–9.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, October 1933*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.90		30.48	25	29.32	16
Reykjavik, Iceland	29.81	+0.13	30.72	25	28.99	13
Lerwick, Shetland Islands	29.82	+.03	30.44	2	28.86	11
Valencia, Ireland	29.95	+.04	30.48	26	29.25	9
Lisbon, Portugal	30.01	−.01	30.23	30	29.62	22
Madeira	29.95	−.04	30.17	13	29.68	27
Horta, Azores	29.98	−.13	30.32	20	29.63	26
Halifax, Nova Scotia	30.04	.00	30.52	22	28.88	8
Nantucket	30.07	+.02	30.61	21	29.38	7
Hatteras	30.06	.00	30.44	21	29.66	6
Bermuda	30.00	−.07	30.28	20, 21	29.54	7
Turks Island	29.88	−.07	30.02	20	29.72	5
Key West	29.87	−.07	30.08	20	29.09	5
New Orleans	30.02	−.01	30.26	10	29.76	5
Cape Gracias, Nicaragua	29.81	−.01	29.98	12	29.62	2

NOTE.—All data based on a.m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Extratropical cyclones and gales.—The northern steamer routes during the first 7 days of October were practically free of extratropical cyclones, and no gales were reported from this source during the entire period. On the 8th, however, cyclonic conditions overspread the entire northern part of the eastern half of the ocean, and by the 9th and 10th gales of force 8–9 were reported between the 35th meridian and the British Isles, and scattered gales of force 8 between the Azores and the coasts of Spain and France. On the 11th and 12th the principal gale field, with forces of 8, lay north of 50° N. and west of 40° W.

From the 12th to 22d anticyclones largely dominated most extratropical waters south of the 50th parallel, except for moderate intrusions from cyclones centered far to the northward. The principal storm period within these dates was that of the 14th to 17th, during which gales of force 8–10 were reported from near the 55th parallel, between 25° and 45° W.

From about the 18th to 23d a moderate cyclone hovered about the Iberian Peninsula and caused fresh gales (force 8) in the vicinity on the 21st to 23d.

On October 22 a cyclone center gathered near 50° N., 35° W. Owing to interposing high pressure north and east, it was forced to retrograde slowly into lower latitudes until the 27th, when it lay a short distance south of the Azores, afterward spreading in area and disintegrating. Local gales of force 8–9 attended its movements from the 24th to 26th, with the maximum force occurring on the 24th, in 46° N., 37° W. The lowest pressure indicated was 29.42 inches, also on the 24th.

The weather at the close of the month was unsettled over most of the ocean, but with no storm conditions of severity prevailing.

Tropical cyclones.—During the last few days of September 1933 unsettled conditions overspread the lower waters of the Caribbean Sea, where they continued until October 1. On that date a shallow cyclone center was definitely established with a northward movement. During the 2d and 3d the depression advanced almost due north midway between Jamaica and Swan Island. On the morning of the 3d a south gale of force 8 was reported at Negril Point, barometer 29.56 inches, and off the north coast of Cuba, immediately west of Habana, a northeast gale of force 9 was blowing. By night of the 3d the storm

center was close to the Cuban south coast, with the wind at Habana blowing a gale of force 9 from northeast, lowest pressure 29.34, noted at Cienfuegos.

During October 4 (see chart VIII) the center of the storm, now of full hurricane force, crossed Habana between 10 a.m. and noon. During a part of this time the calm was absolute. It was preceded and followed by hurricane velocities. The lowest pressure at Habana, 28.81 inches, occurred near 2 p.m., which was at least 2 or 3 hours later than the occurrence of the lull. This points to an erratic movement of the hurricane center during the period of its recurve toward the northeast. While there was some shipping in the Florida Straits on the 4th, the highest wind force noted at sea was 10, apparently late in the day, in 23°28′ N., 83°12′ W.

On the morning of the 5th the hurricane center lay near the southeast coast of Florida (Miami: wind northeast, force 7; barometer 29.14). At 8 a.m. the American S.S. *Empire Arrow*, Baltimore to Beaumont, reported a corrected pressure reading of 28.53 inches in 25°03′ N., 79°30′ W., indicating the storm to be deepening. Shortly afterward the wind experienced by the ship rose to force 12 from the west. At 7 p.m. of the 5th the storm center was north of the Bahamas, with a whole southeast gale blowing off Great Abaco Island. Near midnight the British S.S. *Humber Arm* reported a northwest gale, force 11, near 28° N., 75° W.

On the morning of the 6th (see chart IX) the storm center was near 29° N., 73° W. At 2 a.m. the American S.S. *Harold Walker* reported a southwest hurricane in 27°12′ N., 74°26′ W., and about an hour later the American S.S. *Heffron* reported a northeast hurricane with uncorrected pressure at 28.30 inches, approximately in 29°50′ N., 74°50′ W. During the morning strong gales to hurricane velocities covered most of the sea between 25°–30° N., and 70°–75° W. At 7 p.m. of the 6th the storm center was west of Bermuda, with a southeast gale of force 9 blowing at the island. Shipping apparently had avoided the thickest of the storm at this time and the maximum reported wind force during the p.m. hours was that of a whole gale (F. 10), near 33° N., 69° W., barometer 28.96 inches.

During the 7th the storm continued intense as it progressed from a position northwest of Bermuda to Nova Scotian waters. A wireless message picked up from the Italian S.S. *Montello* conveyed the information that the Greek S.S. *Annoula* sank at 1:30 a.m. of the 7th in about 34°30′ N., 66°40′ W., and asked that ships keep a lookout for 21 persons missing. The lost ship at the time was within the radius of the storm. A radiogram from Bermuda said that the British S.S. *Lady Nelson* passed through the calm center of the storm, barometer 28.68 inches. This was near 37½° N., 67° W. From midnight of this date until early morning of the 8th the German S.S. *Stuttgart*, in and near 42°17′ N., 65°56′ W., reported a low barometer reading of 28.49 inches and a wind of force 11 from east then west, which sufficiently indicates the virility of the hurricane at this time.

During the morning of the 8th the storm field lay principally south of Nova Scotia, with a pressure of 28.88 inches reported at Halifax, and fresh to strong gales in the vicinity. Gales continued during the day, but of lessening force, as the storm, rapidly decreasing in depth and area, swung east-northeastward south of Newfoundland and on the 9th entered the western edge of a great cyclone system then central west of the British Isles.

The succeeding tropical disturbance was of much less intensity. It originated east of the Bahama Islands on the 25th or 26th, and acquired some energy on the 27th, while central at some distance off the Carolina coasts, with south gales of force 9, pressure 29.32 inches, in 31°32′ N., 72°–73° W., at 7 a.m. Late in the afternoon the American S.S. *Coamo*, near 34° N., 72½° W., reported a whole gale (force 10) from the East, in connection with the disturbance. During the 28th the cyclone moved with great rapidity toward Nova Scotia, and near midnight had acquired greatest depth, as gathered from the report of the Dutch S.S. *Volendam*, which had a pressure of 28.80 inches, in 42°48′ N., 64°06′ W., followed in the early morning of the 9th by the maximum wind force (11, NNW.) shown in the history of the disturbance. During the 29th and 30th the remnant of the storm succeeded in wedging its way into the Gulf of St. Lawrence, between two banks of high pressure, and escaping into Labrador.

On the 31st of the month a further depression of the Tropics was central over the Windward Passage, lowest pressure reported, 29.58 inches. At or near 8 a.m. of this date the American S.S. *Gulfhawk* experienced a maximum wind force of 9 from east-northeast, in 23°42′ N., 74°42′ W. The depression originated in the southwestern Caribbean about October 27, and early in November was still of slight intensity.

North Atlantic aviation.—During the flights of the *Graf Zeppelin* this month, the ship set a record of 71 hours for a return trip from Rio de Janeiro to Fredrichshafen, where she arrived on the 10th. On this date the ship was undoubtedly assisted by the strong southerly winds then blowing over the northeastern Atlantic. In a later flight from the United States she left land at Cape May, N.J., on a return trip to Europe, succeeded in dodging the high winds occasioned by the disturbance in the western Atlantic on the 30th, but was delayed by unfavorable winds on the 31st. Charts X and XI show weather conditions over the North Atlantic during these two dates.

Fog.—The region of most frequent fog this month was that lying between Newfoundland and the Grand Banks and about 45° W., with 20 to 30 percent days of occurrence. East of the 45th meridian, the greater part of the transatlantic fog was observed between 50° and 55° N., with 1 to 6 days of occurrence, diminishing eastward. It was noted on 2 days off the coast of France, on 3 days in New England waters, and on 1 day each northeast of Hatteras and in the west-central Gulf of Mexico.

OCEAN GALES AND STORMS, OCTOBER 1933

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Baron Kelvin, Br.S.S.	Newport News.	Manati	27 08 N.	73 40 W.	Oct. 1	4p, Oct. 2	Oct. 2	29.90	ESE	E., 9	E	E., 9	Steady.
Pennsylvania, Am.S.S.	Havana	Cristobal	23 10 N.	82 25 W.	Oct. 3	9p, 3	Oct. 4	29.40	NE	NE., 9	NNW	NE., 9	Do.
Gateway City, Am.S.S.	Avonmouth	Boca Grande	24 23 N.	82 53 W.	do	4a, 4	Oct. 5	29.28	ENE	ENE., 9	N	NE., 9	ENE.-NE.
Sylvan Arrow, Am.S.S.	Beaumont	New York	23 28 N.	83 12 W.	Oct. 4	1a, 5	Oct. 6	29.35	NE	N	N	—, 10	N.-NW.-N.
City of Joliet, Am.S.S.	New Orleans	Havre	25 00 N.	85 30 W.	Oct. 3	4a, 5	Oct. 5	29.51	ENE	NNE., 8	NNW	NNE., 9	NE.-NNE.-N.
Empire Arrow, Am.S.S.	Baltimore	Beaumont	25 03 N.	79 30 W.	Oct. 5	8a, 5	do	28.53	SE	SE., 10	NW	W., 12	SE.-NE.
Humber Arm, Br.S.S.	Cornerbrook	New Orleans	28 00 N.	75 10 W.	do	11p, 5	Oct. 6	28.78	SE	E., 10	WNW	NW., 11	ESE.-E.-NW.
Harold Walker, Am.S.S.	New York	Cristobal	27 12 N.	74 26 W.	do	Mdt, 5	do	28.76	S	S., 12	W	SW., 12	S.-SW.
Lebore, Am.S.S.	Baltimore	do	[1]29 34 N.	[1]74 30 W.	do	do	do	[2]28.42	E	Calm	W	WSW., 10	SSE.-Calm-SW.
Heffron, Am.S.S.	Norfolk	Colon	[1]29 50 N.	[1]74 50 W.	do	3a, 6	do	[2]28.30	SE	NE., 12	NW	ENE., 12	E.-NE.-N.
Virginian, Am.S.S.	New York	Cristobal	29 48 N.	74 12 W.	Oct. 6	4a, 6	do	29.12	NE	N., 9	NW	N., 9	N.-NW.
Gulfhawk, Am.M.S.	Philadelphia	Las Piedras	28 00 N.	71 15 W.	Oct. 5	6a, 6	do	[2]29.30	SSE	SSW., 11	SW	SSW., 11	S-.SSW.-SW.
Java Arrow, Am.S.S.	New York	Colon	31 10 N.	74 00 W.	Oct. 6	10a, 6	Oct. 7	29.33	ENE	N., 8	NW	NNW., 10	NE.-N.-NW.
Dordrecht, Du.S.S.	New Orleans	Liverpool	36 10 N.	71 04 W.	do	6p, 6	do	29.17	NNE	NNE., 7	NW	N., 8	NNE.-N.
Victolite, Br.M.S.	Halifax	Cartagena	33 10 N.	69 15 W.	do	9p, 6	do	28.96	ESE	NNW., 10	W	NNW., 10	ESE.-N.
City of Omaha, Am.S.S.	Rotterdam	Tampa	29 40 N.	64 20 W.	do	Mdt, 6	do	29.61	SSE	S., 9	SSW	S., 9	SSE.-S.-SSW.
City of Baltimore, Am. S.S.	Havre	Norfolk	42 02 N	53 00 W	Oct. 7	Mdt, 7	Oct. 8	29.28	SSE	S, 9	WNW	SW, 10	SSE-S-SW.
Stuttgart, Ger.S.S.	Bremerhaven	New York	42 17 N	65 56 W	do	do	do	28.49	E	E, 11	W	W, 11	E-W.
Statendam, Du.S.S.	Rotterdam	do	50 56 N	16 10 W	Oct. 8	3a, 9	Oct. 10	28.95	SSW	S, 9	NNW	S, 9	S-W.
Soekaboemi, Du.S.S.	Gibraltar	Halifax	43 42 N	33 50 W	do	5p, 9	do	29.43	SW	SW, 5	NE	SW, 9	SW-N.
Orion, Du.S.S.	Amsterdam	San Juan	44 00 N	21 00 W	Oct. 9	10a, 10	do	29.40	W	NE, 8	NE	NE, 9	S-NE.
Crijnssen, Du.S.S.	Dover	Barbados	44 13 N	14 29 W	do	4p, 10	Oct. 11	29.38	SW	SW, 8	NE	SW, 8	SW-NW.
Endicott, Am.S.S.	Hull	Tampa	46 32 N	11 21 W	do	5p, 10	Oct. 10	29.22	SW	NW, 6	S	S, 8	S-NW.
Boston City, Br.S.S.	Straits of Belle Isle.	Montreal	[1]50 05 N	[1]61 20 W	Oct. 10	3a, 11	Oct. 11	29.39	SE	S, —	W	WSW, 8	SSE-S-SSW.
United States, Dan.S.S.	Oslo	New York	52 18 N	41 10 W	Oct. 11	2a, 12	Oct. 12	29.35	SSW	SW, 6	W	W, 8	SW-W.
Scanpenn, Am.S.S.	Copenhagen	do	57 14 N	21 33 W	Oct. 12	Mdt, 12	Oct. 13	29.39	SW	SW, 8	W	SW, 8	SW-W.
Do	do	do	55 58 N	27 53 W	Oct. 14	7a, 14	Oct. 14	29.64	SW	SW, 7	W	W, 9	SW-W.
Themisto, Du.S.S.	Swansea	Montreal	53 13 N	44 03 W	Oct. 15	3a, 16	Oct. 17	29.23	SE	WSW, 9	NW	WSW, 9	SSW-WSW.
Saccarappa, Am.S.S.	Hamburg	Wilmington	54 33 N	36 33 W	Oct. 17	11p, 16	do	29.30	NW	WNW, 7	NW	NW, 10	WSW-WNW-NNW.
Black Tern, Am.S.S.	Antwerp	New York	47 34 N	35 21 W	do	2a, 17	do	29.67	SW	W, 7	SW	SW, 8	SW-W-NW.
Delfshaven, Du.S.S.	do	Norfolk	51 14 N	21 34 W	do	4p, 17	Oct. 18	29.43	SSW	NW, 8	NW	NW, 8	SSW-NW.
San Simeon, Am.S.S.	Colon	Baltimore	15 27 N	76 14 W	Oct. 19	4p, 19	Oct. 20	29.77	NE	NE, 6	E	NE, 8	
Delfshaven, Du.S.S.	Antwerp	Norfolk	48 16 N	46 57 W	Oct. 21	9p, 21	Oct. 22	29.78	SSW	NW, 8	N	N, 8	SSW-NW-N.
Exmouth, Am.S.S.	New York	Casablanca	36 00 N	16 00 W	do	Mdt, 21	do	29.66	NW	NW, 8	NW	NW, 8	NNW-NW-NNW.
Leto, Du.S.S.	Swansea	Montreal	53 31 N	36 10 W	Oct. 22	8a, 23	Oct. 23	29.59	ESE	ENE, 8	E	ENE, 8	E-ENE.
Independence Hall, Am. S.S.	Bordeaux	New York	46 00 N	36 58 W	Oct. 24	2a, 24	Oct. 24	29.49	NNW	NNW, 4	NNE	NW, 9	Steady.
General von Steuben, Ger. S.S.	Galway	Halifax	52 21 N	28 48 W	do	4a, 24	do	30.13	ESE	ESE, 8	ENE	—, 9	ESE-ENE.
Toltec, Br.S.S.	Santa Marta	Bremerhaven	42 40 N	31 22 W	Oct. 23	6p, 24	Oct. 25	29.42	NNW	SW, 6	E	W, 8	W-WSW-SW.
Makiki, Am.S.S.	Colon	New York	[1]34 50 N	[1]74 24 W	Oct. 24	4a, 25	do	29.66	E	NW, 6	N	N, 8	NE-NW-N.
Camito, Br.S.S.	Barbados	Rotterdam	39 45 N	30 20 W	Oct. 25	8a, 25	Oct. 26	29.52	SE	SW, 6	ENE	E, 8	W-S.
Delfshaven, Du.S.S.	Antwerp	Norfolk	43 51 N	62 49 W	Oct. 24	2p, 25	do	29.16	SSE	WNW, 8	NW	W, 9	SSE-W-NW.
Oranian, Br.S.S.	Liverpool	Boston	43 19 N	59 48 W	Oct. 25	4p, 25	do	29.49	SE	SE, 9	WNW	SE, 9	SE-SW.
Georgia, Dan.S.S.	Montreal	Copenhagen	52 23 N	54 00 W	do	8a, 26	do	29.65	ESE	S, 10	S	SSE, 10	SE-S.
Kenbane Head, Br.S.S.	Leith	Montreal	58 45 N	4 05 W	Oct. 26	Noon, 27	Oct. 29	29.30	NW	N, 10	NNW	—, 10	N-NNE.
Toltec, Br.S.S.	Santa Marta	Bremerhaven	49 46 N	5 10 W	Oct. 27	1p, 27	Oct. 28	29.28	NW	NNW, 7	N	NW, 8	NW-NNW-N.
Independence Hall, Am. S.S.	Bordeaux	New York	42 00 N	64 45 W	Oct. 28	9p, 28	Oct. 29	29.12	NE	NE, 11	NNW	N, 12	NE-N.
Volendam, Du.S.S.	Rotterdam	do	42 48 N	64 06 W	do	Mdt. 28	do	28.80	ENE	N, 10	NW	NNW, 11	NE-NW.
Adria, Ger.M.S.	Port Arthur	Bordeaux	39 30 N	58 30 W	do	4a, 29	do	29.76	SE	S, 10	SSW	S, 10	SE-S.
Yoro, Hond.S.S.	New York	Jamaica	17 50 N	76 37 W	Oct. 29	4p, 29	Oct. 30	29.69	E	S, 8	W	W, 8	ESE-SE-S.
Scanyork, Am.S.S.	Copenhagen	New York	58 00 N	16 30 W	Oct. 30	6p, 30	Oct. 31	29.82	W	WNW, 7	W	WNW, 8	Steady.
Gulfhawk, Am.S.S.	Philadelphia	Las Piedras	23 42 N	74 42 W	Oct. 31	8a, 31	Nov. 1	29.94	ENE	ENE, 9	NE	ENE, 9	ENE-NE.
NORTH PACIFIC OCEAN													
Golden Wall, Am.S.S.	Philippines	San Francisco.	39 50 N	165 18 E	Oct. 2	6p, Oct. 2	Oct. 3	29.33	SE	WNW, 5	NNE	N., 10	WSW-WNW-N.
President Jefferson, Am. SS.	Seattle	Yokohama	52 18N	144 30 W	do	2a, 3	do	29.15	S	SSW, 9	SW	SSW, 9	S-SSW-SW.
Ogura Maru, Jap. M.S.	Yokohama	Los Angeles	40 02 N	172 27 E	do	8a, 3	do	29.21	ESE	NE, 7	N	N, 9	ENE-NE-N.
Texas, Am.S.S.	Port Real, P.I.	San Francisco.	42 00 N	164 03 W	do	2p, 3	Oct. 5	29.22	E	SW, 5	NW	NW, 9	SW-NW.
Kiyo Maru, Jap.S.S.	Los Angeles	Yebisu	37 35 N	164 30 W	Oct. 3	do	Oct. 3	29.62	S	SW	NW	W, 10	S-SW-W.
Clydefield, Br.M.S.	do	Balboa	9 45 N	86 30 W	do	4p, 3	Oct. 4	29.89	SW	SW, 7	SW	SW, 7	None.
Silverguava, Br.M.S.	Cebu	Vancouver	36 53 N	151 39 E	do	3a, 4	Oct. 6	29.51	ESE	N, 9	WNW	NW, 10	NE-N-NW.
President Jefferson, Am. SS.	Seattle	Yokohama	52 20 N	158 25 W	Oct. 4	8a, 4	Oct. 5	29.25	NE	NNE, 9	NW	N, 10	NE-NNE-N.
Juyo Maru, Jap. S.S.	Muroran	Seattle	50 10 N	159 29 W	Oct. 3	Noon, 4	do	29.43	NNE	N, 10	WNW	N, 10	N-NNW.
Tyndareus, Br.S.S.	Yokohama	Victoria	49 55 N	159 30 W	Oct. 4	4p, 4	do	29.50	NNW	NW, 9	NW	NW, 9	None.
Yeiyo Maru, Jap.S.S.	do	Los Angeles	42 00 N	159 50 E	do	10p, 4	Oct. 7	28.66	E	E	W	WSW, 10	14 points.
San Luis Maru, Jap. M.S.	Kudamatsu, Japan.	San Luis	40 50 N	167 00 E	do	11p, 4	Oct. 5	29.65	ESE	SSE, 7	SW	SE, 11	SE-S-SW.
San Diego Maru, Jap. M.S.	Yokohama	San Francisco.	43 06 N	161 27 E	do	Mdt, 4	Oct. 6	28.55	E	NE, 10	WNW	ENE, 11	E-NE-N.
Golden Sun, Am. S.S.	Longview	Kobe	51 31 N	142 30 W	do	3a, 5	Oct. 5	29.23	SSE	S, 10	SW	S, 10	S-SSW.
Golden Wall, Am.S.S.	Philippines	San Francisco.	39 56 N	173 24 E	do	6a, 5	do	29.86	ESE	S, 10	SSW	S, 10	
City of Vancouver, Br. S.S.	Muroran	Seattle	47 57 N	170 06 W	Oct. 5	2a, 6	Oct. 6	29.36	S	SW, 9	WSW	SW, 9	SSW-SW.
Choyo Maru, Jap.S.S.	do	Vancouver	50 12 N	160 05 W	Oct. 6	2p, 6	do	[2]29.26	S	S, 7	S	S, 8	
Richmond, Am.S.S.	Honolulu	Los Angeles	28 02 N	141 35 W	do	2a, 7	Oct. 8	29.74	NNW	N, 6	SE	SE, 8	N-NNE-S.
San Luis Maru, Jap.M.S.	Kudamatsu	San Luis	44 08 N	179 49 E	do	Noon, 7	Oct. 7	29.85	WSW	WSW, 9	W	WSW, 9	WSW-W.
Silverguava, Br.M.S.	Cebu	Vancouver	46 50 N	172 15 W	Oct. 8	6p, 8	Oct. 9	29.90	SE	S, 9	SW	S, 9	SE-S-SW.
Heian Maru, Jap.M.S.	Yokohama	do	49 50 N	172 52 W	Oct. 10	4p, 10	Oct. 11	29.18	WSW	WSW, 7	W	WSW, 9	None.
Kiyo Maru, Jap.S.S.	Los Angeles	Yebisu	41 35 N	141 08 E	Oct. 16	10p, 16	Oct. 16	29.59	ENE	N, 6	N	NE, 8	NE-N.
Silverbelle, Br.M.S.	Manila	Los Angeles	20 30 N	125 54 E	do	3p, 17	Oct. 18	29.31	N	NNW, 11	WSW	NNW, 11	NNW-W.
Golden Sun, Am.S.S.	Longview	Kobe	47 00 N	165 07 E	Oct. 17	6a, 18	do	28.92	SSE	SSW, 7	WNW	SE, 10	SSW-W.
Shelton, Am.S.S.	Cebu	Los Angeles	41 11 N	153 50 W	Oct. 16	Mdt, 18	do	29.61	NE	S, 7	E	NE, 9	SSE-S.
Pres. Grant, Am.S.S.	Victoria	Yokohama	49 21 N	175 02 E	Oct. 19	8p, 19	Oct. 19	29.15	SE	SE, 10	S	SE, 10	SE-SSW

[1] Position approximate.
[2] Barometer uncorrected.

OCEAN GALES AND STORMS, OCTOBER 1933—Continued

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH PACIFIC OCEAN—Contd.			° ′	° ′				Inches					
Stanley Dollar, Am.S.S.	Siain	Portland, Ore.	41 46 N	169 35 E	Oct. 21	Noon, 21	Oct. 22	29.62	NW	NW, 6	NNW	NW, 9	None.
San Pedro Maru, Jap. M.S.	Yokohama	San Francisco.	45 14 N	147 37 W	Oct. 19	Mdt, 22.	Oct. 23	28.96	E	S, 5	WSW	E, 9	S.
Olympia Maru, Jap.M.S.	Dairen	Los Angeles	[1] 41 54 N	[1] 146 20 E	Oct. 20	6a, 22	Oct. 22	[2] 29.25	E	W, 6	NNW	NW, 9	E-S-W.
Pres. Jackson, Am.S.S.	Yokohama	Victoria	36 33 N	143 23 E	Oct. 22	8a, 22	do	29.60	NW	NW, 8	NW	NW, 8	
Ryoyo Maru, Jap.M.S.	do	Los Angeles	42 10 N	158 15 E	Oct. 20	3a, 23	Oct. 24	29.29	ENE	WNW, 7	N	NNW, 10.	W-WNW-NW.
Pres. Grant, Am.S.S.	Victoria	Yokohama	45 30 N	162 30 E	Oct. 22	4a, 23	Oct. 23	28.98	ESE	ENE, 8	NNW	NE, 10	ENE-NE.
Stanley Dollar, Am.S.S.	Siain	Portland, Ore.	45 40 N	178 10 W	Oct. 23	5a, 23	Oct. 24	29.00	SE	ESE, 9	NNE	SE, 11	SE-E.
Everett, Am.S.S.	Dairen	Seattle	48 30 N	150 30 W	Oct. 22	3p, 23	Oct. 23	28.83	E	NNE, 9	NNE	E, 11	NNE-N.
Empress of Russia, Br. S.S.	Vancouver	Yokohama	51 46 N	143 26 W	Oct. 23	5p, 23	do	28.93	E	NE, 9	NE	ENE, 9	ENE-NE.
General Pershing, Am. S.S.	Yokohama	San Francisco.	40 25 N	177 28 W	do	11p, 23	do	29.17	S	WSW, 3	S	S, 9	WSW-W.
Olympia Maru, Jap.M.S.	Dairen	Los Angeles	41 58 N	160 57 E	Oct. 24	Mdt, 24.	Oct. 24	[2] 29.48	S	W, 6	S	S, 8	S-SW-W.
Pres. Jackson, Am.S.S.	Yokohama	Victoria	45 30 N	165 45 E	do	6a, 25	Oct. 25	29.29	SSE	SE, 7	S	S, 9	S-SE.
Pres. Grant, Am.S.S.	Victoria	Yokohama	40 12 N	148 15 E	Oct. 25	7a, 25	do	29.55	WNW	WNW, 8	WNW	WNW, 8	
Stanley Dollar, Am.S.S.	Siain	Portland, Ore.	47 48 N	163 18 W	Oct. 26	1p, 26	Oct. 27	29.33	WSW	SW, 7	W	WSW, 8	SW-WSW.
Hakonesan Maru, Jap. M.S.	Yokohama	Los Angeles	37 05 N	144 34 E	Oct. 30	4p, 30	Oct. 31	29.84	NNE	NE, 7	NNW	NE, 8	NNE-NE.

[1] Position approximate.
[2] Barometer uncorrected.

NORTH PACIFIC OCEAN, OCTOBER 1933

By WILLIS E. HURD

Atmospheric pressure.—The pressure situation over the North Pacific Ocean during October 1933 was in the main close to normal but showed a few marked departures. Over the central Aleutian Islands and in the southern part of Bering Sea the averages for the month were about a tenth of an inch above the normal. In the southwestern ocean, while the Japanese island groups south of Japan proper had pressures 0.05 to 0.06 above the normal, the average at Manila was 0.09 inch below.

The Aleutian cyclone was well established in October, central over the Alaska Peninsula and neighboring islands. The Pacific anticyclone covered a great belt of ocean extending from the upper United States coast westward to beyond Midway Island. It was much intruded upon by frequent cyclonic disturbances in northern and central waters, particularly from the 1st to the 7th and the 18th to 31st.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, October 1933, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.93	0.00	30.84	20	29.46	27
Dutch Harbor	29.70	+.05	30.38	17	29.00	26
St. Paul	29.73	+.10	30.28	17, 18	28.98	26
Kodiak	29.71	+.12	30.42	19	28.88	11
Juneau	29.89	+.02	30.67	21	29.08	28
Tatoosh Island	30.02	+.01	30.41	16	29.24	28
San Francisco	29.98	−.03	30.19	16	29.58	30
Mazatlan	29.86	+.02	29.94	11, 12	29.76	4, 5
Honolulu	30.02	+.02	30.14	26	29.87	17
Midway Island	30.03	.00	30.18	27	29.78	21, 23
Guam	29.87	+.03	29.98	22, 23	29.74	10, 14
Manila	29.78	−.09	29.92	27	29.68	15
Naha	29.96	+.06	30.18	27	29.56	18
Chichishima	29.96	+.05	30.20	27	29.70	20
Nemuro	29.93		30.40	12	29.30	16

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—Progressive and fluctuating cyclones of considerable depth and severity caused much rough weather along the northern steamship routes, and gales were reported on 2 to 4 or more days of the month in each 5° square north of the fortieth parallel and west of 140° west longitude. The preponderating number of gale reports indicated that wind forces of 9 to 10 usually occurred during at least one or more hours of the storm experiences of the reporting ship, and were noted on at least a third of the days in the month.

The principal stormy periods in extratropical waters were the 3d to 5th and the 22d to 24th. The main storm region of the earlier period lay between 35° and 45° N., 150° and 170° E. The highest wind velocity noted was force 11. This was reported by the Japanese motor ship *San Luis Maru* on the 4th, near 41° N., 167° E., and by the Japanese motor ship *San Diego Maru* on the 5th, near 43° N., 161° E. The *San Diego Maru* reported the lowest pressure reading of the month, 28.55 inches, at midnight of the 4th–5th. Scattered gales were experienced on the same dates of the period, as noted in the table of gales.

During the second major storm period (22d–24th) whole gales (force 10) to storm winds (force 11) occurred at various points north of the 40th parallel, between approximately 160° E. and 150° W. In the western part of the area, they resulted from the typhoon, later described, which was then centered east or southeast of the Kuril Islands. In mid-Pacific, a southeast gale of force 11, with pressure noted as low as 29 inches on the 22d, was due to a cyclone then centered near 46° N., 178° W. This storm, which covered a wide area, spread eastward during the three succeeding days, and caused gales of force 10–11, with pressures below 29 inches, on the 23d and 24th. On these 2 days the greatest storm intensity occurred, roughly, between 40° and 50° N., 150° and 170° W. On the 25th the severity had subsided.

Typhoon.—Reports thus far received show that one typhoon, and that of hurricane severity, traversed the waters of the Far East in October 1933. It was first discovered as a depression north of Yap about the 11th. Its movement appears to have been somewhat uncertain until the 15th, on which date a clear northwestward advance was indicated. The British motor ship *Silverbelle*, Manila toward San Pedro, encountered northerly gales in front of the typhoon late on the 16th, near 21° N., 125° E., and on the 17th met with the full hurricane force of the approaching storm, lowest pressure 29.31 inches. On the 18th, east of Taiwan, the typhoon recurved northward across the Eastern Sea, passing west of the Nansei

Islands. During the 19th and 20th it crossed the two southernmost islands of Japan proper. Late on the 20th it crossed northern Honshu and emerged into the Pacific. Its later course was followed until the 23d, when it lay southeast of the Kuril Islands.

According to press reports, 1,000 fishing boats and 2,000 Japanese fishermen were missing after the devastation of Shikoku Island by the typhoon on the 20th. The Japanese steamer *Yashima Maru* foundered off Suma at this time with 54 out of 107 persons on board reported lost. At sea on the 22d and 23d, gales of force 9 and 10 were reported as accompanying the storm between the Japanese coast and about 165° E.

A depression that appeared east of the Philippines on October 31 caused the loss of a few lives and some damage to property over the Visayas on November 1 or 2.

Fog.—Frequent fog mantled the coastal waters of the United States. From Eureka to San Pedro about 50 percent of the October days had fog. Between Eureka and Vancouver Island and along the west coast of Lower California, it occurred on 30 to 35 percent of the days. For some distance outside this fog belt there were greatly lessened occurrences seaward, and over the great body of the northern routes it occurred on not to exceed 1 or 2 days in the several 5° squares.

TYPHOONS IN THE FAR EAST DURING OCTOBER 1933

By Rev. C. E. Deppermann, S.J.

[Weather Bureau, Manila, P.I., November 1933]

(1) *October 11.*—Although suspected on October 10, this typhoon was not certain until the next day. It was rather low in latitude, on the tropical front between Yap and Palau. Traveling northwest for 2 days until within about 200 miles of mid-Philippines, it then turned north until the 17th. From the 12th on, the tropical front could be distinctly traced on our maps as it progressed northward, but since the southwest monsoon was not strong within the islands, we conclude that it had already been forced out of the center of the typhoon, i.e., the typhoon had occluded very early. This conjecture is strengthened by the fact that the northeast monsoon apparently reached to the Philippines at the time; hence it is probable that the typhoon was now mainly fed by temperature differences between the northeast monsoon and the trade wind. Why did the typhoon take the path it did? Without upper-air data this is difficult to decide, but it was noticed that pressure was decreasing all the time to the northeast and over the Bonins, with rather strong northeast winds right above the Philippines. It is probable that the upper winds recurved in the direction the typhoon took. On the 17th the typhoon suddenly turned to the northwest till it reached the lower Nansei group, and then finally definitely recurved in a northeast direction along the polar front until around north Japan, whence it turned eastward. Even though the typhoon occluded early, there seems apparently to have remained, until the storm was well within Japan, a well-marked front between the northeast monsoon and the trade all the way from the typhoon to near the Philippines, where there seems to have been an interesting junction of the southwest monsoon, the northeast monsoon, and the trade. Since the typhoon kept a course over water until near Japan, where its intensity had already abated, comparatively little damage was reported, except that in Japan an excursion steamer foundered right in sight of port, with the loss of some 40 lives.

(2) *October 14.*—This was a very small typhoon, but with some interesting and instructive features. As the typhoon of October 11, above mentioned, progressed, the tropical front became more in evidence, from the southernmost tip of Indo-China over to mid-Philippines and on to the typhoon. Above this front there were strong northeasterly winds, continuing down the coastline of Indo-China until they reached the end of the coastal range. At this point they met the southwest monsoon. The situation seems ideal for causing vortices. At any rate, near this part of the China Sea a small typhoon did form, and apparently proceeded in the rather unusual direction, southwest, until it reached this southern tip of the coastal range. It then dissipated over land in the interior

(3) *October 23.*—Due to lack of sufficient data, the explanation of the origin of this typhoon is only tentative, but it appears quite plausible. As the typhoon of October 11 moved finally northeast, the front between the northerly winds and the trade progressed slowly but steadily eastward until the typhoon had reached northern Japan. Then the trade started to surge back rapidly. In this way, a secondary probably started at the junction of trade, northeast, and southwest monsoons. This secondary remained as a swift depression until just after it coursed through northern Philippines. Here its further progress was apparently blocked by the southern part of the Asiatic high-pressure area. The quick transition from a speed of about 35 miles per hour to almost nothing was remarkable. Remaining almost stationary for a day, the depression intensified into a true typhoon, and then proceeded comparatively slowly toward Indo-China. Before the depression passed through our islands, the tropical front was in evidence, but no squalls were present to indicate anything alarming.

(4) *October 26.*—This typhoon appears to have been brooding to the southwest of Yap as early as the 25th, at the meeting place of trade and southwest monsoon, but it did not start to move decidedly until the 27th. On the afternoon and evening of the 28th it remained almost stationary, but then started swiftly at the rate of over 30 miles an hour in a west-northwest direction toward the southern Philippines, giving us barely enough time for proper typhoon warnings for the people. Through the islands it still moved quite rapidly, about 20 miles an hour, and then leisurely crossed the China Sea and entered Indo-China. Fortunately the typhoon was only of moderate intensity (these usually move faster than the more intense typhoons), and directly struck land in the Philippines only in a few places. As it was, however, 15 or more lives were lost and quite some property damaged. How about the fronts as the typhoon passed through the islands? This question cannot be answered until all our barograph records have been received from the stations near the typhoon. However, it is quite probable that Father Gherzi and others are correct in stating that close to the center of a typhoon, i.e., in the region of very strong winds in the typhoon proper, no fronts can exist.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, October 1933

[For description of tables and charts, see REVIEW, January, p. 37]

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	66.5	+1.9	Union Springs	98	1	St. Bernard	32	9	1.95	−0.76	Milltown	5.05	Alaga	0.25
Arizona	67.4	+3.9	3 stations	108	2	Williams	21	22	1.25	+.46	Pinedale	5.24	Wikieup	.00
Arkansas	62.6	+.1	do	90	[1] 1	Dutton	30	8	2.85	−.30	Dutton	7.73	Higden	.58
California	64.4	+3.9	2 stations	109	[1] 1	Tule Lake	7	21	1.52	+.31	Bowman Dam	7.80	7 stations	.00
Colorado	51.2	+4.7	Palisade	92	1	Dillon	4	15	.29	−.91	Cumbres	2.16	43 stations	.00
Florida	74.7	+1.6	Panama City	96	[1] 1	Garnier (near)	37	10	4.83	+.55	Key West	23.56	Monticello	.12
Georgia	66.7	+1.8	Millen	98	1	Clayton	26	26	2.11	−.56	Savannah	7.50	3 stations	.07
Idaho	50.6	+3.7	Indian Cove	91	6	Obsidian	0	21	1.67	+.28	Roland	10.26	2 stations	.00
Illinois	53.9	−1.1	2 stations	88	31	Mt. Carroll	20	25	2.77	.00	Carlinville	5.30	Galena	.96
Indiana	53.8	−.9	Crawfordville	89	1	6 stations	26	[1] 25	2.77	−.02	Laporte	7.52	Greenfield	.97
Iowa	50.1	−1.3	Keokuk	84	31	Sanborn	17	25	1.36	−1.03	Baxter	4.04	2 stations	.22
Kansas	57.8	+.9	Anthony	89	10	Oberlin	21	9	.86	−1.10	Pleasanton	5.88	do	.00
Kentucky	57.4	−.8	2 stations	88	[1] 1	Quicksand	23	26	2.05	−.71	Lovelaceville	4.40	Whitesburg	.44
Lousiana	70.3	+2.1	do	95	1	Tallulah	30	26	1.42	−1.90	Shreveport	4.55	Loganport	.20
Maryland-Delaware	55.0	−1.2	Clear Spring, Md	92	1	3 stations	16	26	1.95	−.93	Chewsville, Md	3.84	Bridgeville, Del	.88
Michigan	47.3	−1.7	2 stations	82	31	Sidnaw	0	28	4.31	+1.58	Deer Park	7.79	Ypsilanti	.82
Minnesota	43.0	−3.3	do	87	14	Mizpah	−5	28	1.44	−.51	Tower	5.52	Pipestone	.05
Mississippi	66.8	+1.6	Columbia	98	1	Batesville	31	26	1.57	−1.06	Anguilla	4.72	Crystal Springs	.02
Missouri	56.4	−.9	2 stations	86	[1] 1	Downing	23	25	2.68	−.18	Hailey	6.59	Bethel	.74
Montana	46.3	+1.9	Ballantine	91	8	Babb (near)	−5	21	1.49	+.46	Haugan	6.85	Ingomar (near)	.15
Nebraska	53.0	+1.9	2 stations	91	[1] 4	Nenzel	9	22	.06	−1.54	Falls City	1.10	63 stations	.00
Nevada	57.9	+7.6	Logandale	102	2	Zorra Vista Ranch	8	21	.59	+.04	Lewers Ranch	4.30	5 stations	.00
New England	48.9	−.7	3 stations	79	1	Greenville, Me	11	26	4.00	+.43	Nantucket, Mass	8.31	Milford, Mass	1.55
New Jersey	53.6	−1.1	Bridgeton	84	1	Runyon	18	29	2.04	−1.37	Culvers Lake	3.37	Bridgeton	.85
New Mexico	56.6	+3.0	Carlsbad	97	1	Elizabethtown	7	[1] 16	.86	−.32	Cousins	3.40	10 stations	.00
New York	48.5	−1.5	Port Jervis	82	1	3 stations	6	6	2.51	−.80	Bridgehampton	4.17	Haskinville	.68
North Carolina	60.9	+1.0	2 stations	95	1	Mount Mitchell	20	25	1.36	−2.02	Mount Mitchell	4.63	New Holland	.00
North Dakota	41.5	−2.0	Oakes	88	14	2 stations	5	[1] 25	.53	−.51	Grand Forks	1.33	Hankinson	.00
Ohio	52.4	−1.0	Waverly	87	21	Dover	20	26	1.36	−1.24	Hamilton	2.62	2 stations	.34
Oklahoma	63.3	+1.1	Hugo	98	7	Boise City	24	22	3.51	−.52	Purcell	6.00	Waurika	.12
Oregon	52.9	+3.3	Wolf Creek	98	3	Lake	0	21	2.11	+.33	Headworks	11.27	Dayville	.24
Pennsylvania	51.6	−.8	Phoenixville	90	1	Wellsboro	11	26	1.91	−1.35	Freeland	3.80	Irwin	.33
South Carolina	63.9	−.3	Kingstree	95	1	Caesars Head	29	26	1.71	−1.32	Aiken	4.65	Marion	.21
South Dakota	49.3	+.9	Vale	94	4	Redfield	12	12	.12	−1.19	Ludlow	.91	9 stations	.00
Tennessee	60.1	+.6	Elkmont	94	1	Rugby	24	26	1.24	−1.60	Tiptonville	4.16	Dickson	.14
Texas	70.9	+3.1	Ballinger	99	[1] 17	Dalhart	30	22	1.24	−1.43	San Benito	7.38	8 stations	.00
Utah	54.1	+5.3	2 stations	94	[1] 2	Soldiers Summit	12	22	.45	−.66	Blanding	1.52	4 stations	T
Virginia	56.8	−.6	Roanoke	95	1	Emory	20	26	1.30	−1.72	Manassas	3.37	Langley Field	.10
Washington	50.6	+.6	Wahluke	94	5	Chewsaw	12	21	4.60	+1.69	Snoqualmie Pass	17.05	White Swan	.15
West Virginia	53.6	−1.0	McNeill	91	1	Parsons	13	26	1.67	−1.15	Pickens	4.31	Upper Tract	.40
Wisconsin	45.6	−2.6	2 stations	81	31	Prentice	−3	25	2.44	−.04	Mellen	5.14	Arlington	1.19
Wyoming	47.7	+4.4	do	85	[1] 4	South Pass City	−5	16	.16	−.97	Dome Lake	1.68	34 stations	.00
Alaska (September)	42.8	−1.4	Viewcove	78	8	Alakaket	8	19	2.38	−1.41	Cordova	18.48	White Mountain	.11
Hawaii	77.9	−.3	Bayamon	97	7	Guineo Reservoir	48	23	7.35	−.86	Guineo Reservoir	19.70	Mona Island	.95

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau Stations, October 1933*

Compiled by ANNIE E. SMALL

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							50.7	−0.4										77	4.11	+0.8										5.3		
Eastport	76	67	85	29.99	30.08	+0.08	47.8	+.3	66	2	54	28	26	42	24	45	42	84	6.02	+2.5	14	8,709	sw.	37	ne.	6	8	10	13	6.1	T	0.0
Greenville, Maine	1,070	6		29.91	30.09		43.2		72	16	52	11	26	35	33				4.86		13	5,323	se.	27		26	9	6	16		5.0	
Portland, Maine	103	82	117	29.97	30.09	+.05	50.4	+.5	71	1	58	29	26	43	24	45	41	77	6.72	+3.6	16	6,931	n.	31	s.	17	15	6	10	4.5	T	.0
Concord	289	70	79				48.4	−1.3	76	1	59	23	27	38	42				4.90		14		ne.								T	.0
Burlington	403	11	48	29.65	30.10	+.06	46.3	−2.9	69	1	54	23	29	38	29				4.26	+1.3	9	7,814	s.	35	s.	22	5	8	18	7.0	1.0	.0
Northfield	876	12	60		30.13	+.09	43.4	−2.1	73	16	54	17	26	32	45			78	2.65	−.2	11	5,750	s.	26	se.	27	3	11	17	7.2	13.0	.0
Boston	125	106	165	29.96	30.10	+.05	52.7	−.9	75	1	61	27	26	44	26	47	43	74	3.11	.0	12	10,789	w.	46	nw.	25	13	10	8	4.6	.0	.0
Nantucket	12	14	90	30.06	30.07	+.02	55.2	+1.0	71	1	61	33	26	50	25	51	48	81	8.31	+4.9	13	11,101	n.	39	n.	7	16	4	11	4.8	.0	.0
Block Island	26	11	46	30.06	30.09	+.04	54.6	−.3	71	1	60	31	26	49	26	51	48	79	3.15	−.4	12	11,972	nw.	49	nw.	25	15	7	9	4.7	.0	.0
Providence	160	215	251	29.92	30.09	+.04	52.6	+.4	75	1	62	27	26	44	25	47	42	72	2.59	−.5	9	8,352	nw.	46	nw.	25	16	6	9	4.1	.0	.0
Hartford	159	70	104		30.10	+.04	52.4	+1.2	74	8	62	28	26	42	33				1.68	−1.8	9	5,246	nw.				16	5	10		.0	.0
New Haven	106	74	153	30.00	30.12	+.06	53.6	−.2	75	1	63	29	26	44	29	48	43	71	2.64	−1.0	8	6,994	n.	33	nw.	25	14	8	9	4.9	.0	.0
Middle Atlantic States							56.0	−.4										74	1.66	−1.4										4.4		
Albany	97	107	115	30.02	30.12	+.06	51.0	−1.1	72	1	60	27	26	42	29	45	41	75	3.14	+.4	10	5,817	s.	24	s.	17	11	11	9	5.2	.0	.0
Binghamton	871	60	68	29.19	30.14	+.08	48.6	−1.4	75	1	59	23	29	38	35				2.49	−.5	9	4,130	nw.	20	nw.	25	8	8	15	6.5	T	.0
New York	314	414	454	29.77	30.11	+.05	55.9	−.4	78	1	64	31	26	48	27	49	44	69	1.98	−1.6	6	9,696	n.	57	nw.	25	11	11	9	5.0	.0	.0
Bellefonte	1,050	5	42	29.00	30.12		47.8		76	1	60	19	26	36	36	43	40	84	2.03		8		w.				11	12	8	5.1	T	.0
Harrisburg	374	94	104	29.72	30.13	+.05	53.8	−1.0	83	1	63	30	26	44	34	47	42	70	2.25	−.7	9	4,767	n.	21	nw.	25	15	10	6	4.3	.0	.0
Philadelphia	114	123	367	30.01	30.14	+.07	57.8	.0	81	1	67	32	26	49	26	50	44	67	1.39	−1.4	5	8,971	n.	39	nw.	25	18	5	8	4.0	.0	.0
Reading	323	283	304	29.78	30.14		55.2	+.5	83	1	65	29	26	45	32	47	42	67	1.55	−1.6	6	7,142	nw.	37	nw.	25	14	11	6	4.3	.0	.0
Scranton	805	72	104	29.26	30.13	+.06	50.9	−1.0	75	1	62	27	29	40	35	45	41	75	2.80	−.2	6	4,922	n.	25	nw.	25	9	16	6	4.9	T	.0
Atlantic City	52	37	172	30.06	30.12	+.05	57.7	+.8	76	1	66	31	26	49	26	53	49	76	1.64	−1.6	6	10,980	nw.	42	nw.	25	17	8	6	4.1	.0	.0
Sandy Hook	22	10	57	30.09	30.11		56.4		78	1	63	34	26	50	24	52	48	77	1.29	−2.5	7	10,305	n.	46	nw.	25	19	6	6	3.8	.0	.0
Trenton	190	159	183	29.92	30.12		54.2	−1.4	80	1	64	29	26	44	35	48	44	73	1.30	−1.5	8	6,126	n.	29	nw.	25	17	9	5	4.2	.0	.0
Baltimore	123	100	215	30.00	30.13	+.05	58.0	−.2	87	1	67	32	26	48	31	51	46	68	1.76	−1.1	8	6,937	n.	34	nw.	25	20	3	8	3.7	.0	.0
Washington	112	62	85	30.01	30.13	+.05	56.5	−.9	86	1	67	31	26	46	34	50	46	76	2.56	−.3	7	4,083	n.	25	nw.	25	18	5	8	4.1	.0	.0
Cape Henry	18	8	54	30.08	30.10		63.6	+1.5	84	8	70	44	26	58	27	58	55	79	.30	−2.7	4	9,829	n.	41	n.	25	19	5	7	4.0	.0	.0
Lynchburg	686	153	188	29.90	30.14	+.05	57.4	−1.1	93	1	72	25	27	42	48				1.45	−1.7	6		n.				17	13	1		.0	.0
Norfolk	91	170	205	30.02	30.12	+.05	63.4	+.9	86	1	71	41	26	56	27	56	52	74	.39	−2.6	4	8,511	ne.	31	n.	25	13	9	9	4.5	.0	.0
Richmond	144	11	52	29.99	30.14	+.06	58.7	−.9	87	1	70	32	26	47	40	51	48	77	.72	−2.2	6	5,249	ne.	23	n.	25	20	5	6	3.4	.0	.0
Wytheville	2,304	49	55	27.74	30.13	+.04	53.0	−.6	85	1	66	24	26	40	38	46	42	73	1.17	−1.7	5	3,976	w.	20	w.	8	17	10	4	3.7	.0	.0
South Atlantic States							65.8	+1.1										76	3.13	−.1										4.3		
Asheville	2,253	89	104	27.78	30.15	+.06	57.0	+1.7	84	1	70	30	26	44	40	49	45	76	1.61	−1.1	4	5,042	nw.	29	nw.	25	17	9	5	4.0	.0	.0
Charlotte	779	244	267	29.28	30.12	+.04	61.8	+.1	88	1	71	35	26	52	28	53	47	65	2.97	.0	3	8,094	n.	34	sw.	8	20	6	5	3.3	.0	.0
Greensboro	886	6	56	29.18	30.14		58.2		90	1	72	30	27	44	36	50	47	80	1.04		4	5,163	ne.	26	sw.	8	17	8	6	3.7	.0	.0
Hatteras	11	5	50	30.06	30.08	+.02	68.4	+2.5	85	1	74	52	26	63	21	64	61	81	.60	−4.4	5	8,669	ne.	32	n.	25	15	9	7	4.1	.0	.0
Raleigh	376	103	146	29.71	30.12	+.05	62.4	+.4	87	1	73	33	26	52	29	54	49	70	.89	−2.0	3	6,408	ne.	24	n.	25	18	4	9	3.7	.0	.0
Wilmington	72	73	106	30.02	30.09	+.03	65.8	+.5	87	2	75	42	26	56	28	59	56	79	.07	−3.2	4	5,654	ne.	22	s.	17	14	8	9	4.4	.0	.0
Charleston	48	11	92	30.01	30.06	.00	68.6	+.8	84	2	75	49	26	62	21	63	60	80	2.81	−.5	7	8,402	ne.	27	ne.	25	14	8	9	4.7	.0	.0
Columbia, S.C.	351	41	57	29.71	30.09	+.02	65.5	+1.2	88	1	76	40	26	55	31	57	53	71	1.05	−1.5	5	4,991	ne.	25	sw.	8	19	6	6	3.4	.0	.0
Augusta	182	62	77	29.88	30.07	.00	66.6	+1.3	90	1	77	43	26	56	34	58	54	73	1.80	−.7	3	4,225	ne.	20	w.	8	16	10	5	4.1	.0	.0
Savannah	65	73	152	29.98	30.05	.00	69.5	+1.6	90	1	78	50	26	61	26	63	60	82	7.50	+4.5	7	7,400	n.	29	s.	21	12	7	12	5.3	.0	.0
Jacksonville	43	209	245	29.95	30.00	−.02	72.0	+.9	86	1	78	56	10	66	24	66	63	80	11.99	+7.5	13	8,882	n.	35	e.	23	9	5	17	6.1	.0	.0
Florida Peninsula							77.7	+.9										80	13.68	+7.8										5.3		
Key West	22	10	64	29.85	29.87	−.07	78.9	−.2	88	17	84	69	31	74	15	74	72	82	23.56	+17.6	19	8,306	ne.	43	nw.	5	13	9	9	4.8	.0	.0
Miami	25	124	168	29.88	29.91	−.06	77.9	+.9	86	6	82	69	25	73	14	73	70	79	15.78	+7.3	20	8,891	ne.	37	ne.	5	2	15	14	7.0	.0	.0
Tampa	35	88	197	29.91	29.95	−.03	76.4	+2.1	89	2	84	63	25	69	22	68	66	79	1.71	−1.4	6	9,476	e.	38	nw.	16	17	7	7	4.1	.0	.0
Titusville	44	5	25	29.91	29.96		75.4		89	9	82	58	14	68	28				8.22		15		ne.								.0	.0
East Gulf States							68.0	+1.6										72	2.01	−.9										4.3		
Atlanta	1,173	190	198	28.86	30.10	+.03	63.8	+.8	86	1	72	42	26	55	23	55	50	69	2.44	−.2	6	7,176	e.	27	nw.	25	19	4	8	4.1	.0	.0
Macon	370	76	84	29.68	30.07	+.01	66.4	+1.9	89	1	77	44	26	56	34	58	53	71	1.68	−.7	5	5,098	ne.	21	ne.	23	13	9	9	4.5	.0	.0
Thomasville	273	49	103	29.74	30.03	−.01	70.8	+2.6	91	1	81	49	10	60	32	62	50	77	.07		2		ne.				10	7	14		.0	.0
Apalachicola	36	11	19	29.95	29.99		71.6		86	2	79	54	10	64	23	65			2.27	−.9	9		ne.				16	10	5		.0	.0
Pensacola	56	149	185	29.96	30.02	−.01	71.1	+1.2	88	2	78	50	26	64	26	63	59	70	2.80	−1.4	5	9,526	ne.	27	se.	29	16	7	8	4.1	.0	.0
Anniston	741	9	57				64.0	+1.6	90	1	75	39	9	53	35				1.70		3		se.				13	13	5		.0	.0
Birmingham	700	11	48	29.32	30.08	+.01	66.6	+1.8	88	1	78	41	9	56	30	56	51	68	1.86	−.6	3	4,864	e.	18	se.	16	17	8	6	3.7	.0	.0
Mobile	57	125	161	29.96	30.02	−.02	70.4	+1.1	92	1	80	46	26	61	28	62	59	75	2.66	−.9	8	6,998	n.	26	n.	25	12	11	8	4.7	.0	.0
Montgomery	218	92	105	29.82	30.07	+.01	68.3	+1.7	91	1	78	47	9	59	30	59	54	68	3.47	+1.0	5	5,112	n.	19	n.	25	12	9	10	4.9	.0	.0
Meridian	375	87	95	29.67	30.06	.00	66.4	+2.1	90	1	77	40	26	56	35	58	54	75	1.69	−.7	6	4,013	ne.	20	ne.	1	14	9	8	4.1	.0	.0
Vicksburg	247	65	73	29.80	30.06	.00	67.2	+.5	86	21	77	40	26	58	28	59	55	74	.55	−2.2	6	4,812	n.	21	nw.	1	12	12	7	4.6	.0	.0
New Orleans	53	76	84	29.96	30.02	−.01	73.4	+2.4	90	2	81	51	26	66	21	65	62	75	.64	−2.7	5	5,496	ne.	18	ne.	30	13	10	8	4.3	.0	.0
West Gulf States							70.7	+2.8										74	2.06	−1.0										3.9		
Shreveport	249	92	227	29.78	30.05	.00	68.2	+1.6	89	1	78	46	26	59	28	61	58	78	4.55	+1.9	6	6,802	ne.	33	ne.	1	18	9	4	3.6	.0	.0
Bentonville	1,303	11	44	28.70	30.07	+.02	58.4	+.4	80	6	70	37	8	47	32				5.33		8	4,147	s.	16	sw.	10	14	8	9		.0	.0
Fort Smith	457	79	94	29.58	30.06	+.01	63.8	+1.0	84	6	74	42	9	53	36	56	51	73	2.35	−.6	9	5,632	e.	23	sw.	15	16	9	6	3.9	.0	.0
Little Rock	357	94	102	29.70	30.08	+.02	63.4	−.2	82	11	73	42	26	53	29	55	50	70	1.61	−1.1	7	5,455	e.	21	s.	15	15	12	4	3.9	.0	.0
Austin	605	136	148	29.37	30.00		74.2	+5.9	95	7	85	54	10	63	32	64	59	68	3.05	−.1	7	4,873	s.	29	ne.	26	11	16	4	4.3	.0	.0
Brownsville	57	88	96	29.89	29.95		77.9	+3.0	91	16	85	66	29	71	19	71	70	84	3.10	−.2	8	5,720	e.	26	se.	17	20	9	2	3.3	.0	.0
Corpus Christi	20	11	78	29.98	30.00	.00	76.8	+3.6	88	16	82	64	27	71	19	71	69	82	1.99	−.5	9	6,867	se.	28	ne.	27	13	11	7	4.4	.0	.0
Dallas	512	220	227	29.48	30.02		69.6		88	15	80	47	9	59	31	60	54	64	.60	−2.1	5	7,988	se.	31	n.	12	19	11	1	3.2	.0	.0
Fort Worth	670	106	114	29.33	30.04	+.01	70.2	+3.5	90	12	81	47	9	60	33				1.24	−1.6	4	6,019	ne.	24	sw.	15	20	8	3	2.8	.0	.0
Galveston	54	106	114	29.95	30.01	−.02	75.6	+2.9	88	7	80	61	26	71	18	69	66	78	4.80	+.4	2	6,733	se.	23	ne.	1	19	6	6	3.8	.0	.0
Houston	138	292	314	29.87	30.02		73.4	+3.1	92	16	82	49	26	65	29				1.92	−1.8	5	7,661	se.	53	n.	22	12	12	7	4.4	.0	.0
Palestine	510	64	72	29.51	30.04	+.01	70.9	+3.7	90	16	82	46	9	60	31	61	56	69	.56	−2.8	4	5,335	ne.	24	ne.	1	15	10	6	3.9	.0	.0
Port Arthur	34	58	66	29.97	30.01		73.6		90	16	82	53	9	66	24	66	64	80	.72	−2.6	2	5,525	e.	23	e.	26	10	20	1	4.1	.0	.0
San Antonio	693	242	301	29.27	29.98	−.03	75.6	+5.1	97	16	86	59	9	66	30	65	60	67	.27	−2.0	5	7,859	e.	30	e.	30	9	17	5	4.9	.0	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, October, 1933*—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air												Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Total	Departure from normal	Days with .01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	Pct.	In.	In.		Miles								0–10	In.	In.
Ohio Valley and Tennessee							57.0	−1.0										70	1.40	−1.3										4.7		
Chattanooga	762	190	215	29.30	30.12	+.03	62.8	+.9	87	1	73	38	26	52	32	54	48	67	1.25	−1.8	3	4,782	ne.	25	w.	1	17	9	5	3.7	.0	.0
Knoxville	995	79	97	29.06	30.12	+.03	61.4	+1.5	87	1	73	38	26	50	35	52	47	68	.39	−2.2	2	3,911	ne.	22	nw.	25	17	12	2	3.3	.0	.0
Memphis	399	78	86	29.66	30.08	+.01	63.4	+.1	83	29	73	39	25	54	30	54	49	68	2.00	−.7	4	5,063	ne.	22	n.	7	19	5	7	3.6	.0	.0
Nashville	546	168	191	29.54	30.13	+.05	60.6	−.4	82	21	71	36	26	50	34	52	47	66	1.23	−1.3	6	6,392	ne.	26	nw.	24	15	7	9	4.4	.0	.0
Lexington	989	193	230				54.6	−2.8	81	21	66	30	26	43	38				2.14		8		e.				16	8	7		.0	.0
Louisville	525	188	234	29.54	30.13	+.05	57.6	−1.7	82	30	68	36	26	48	28	49	44	66	1.82	−.8	6	7,256	n.	36	n.	24	13	10	8	4.7	.0	.0
Evansville	431	76	116	29.64	30.12	+.04	58.4	−1.0	84	31	68	36	26	48	29	50	44	68	3.11	+.3	9	6,275	ne.	24	n.	24	14	7	10	4.5	.0	.0
Indianapolis	822	194	230	29.23	30.12	+.05	54.0	−1.7	80	31	63	33	25	45	29	47	41	67	1.28	−1.5	7	7,740	s.	32	nw.	24	13	12	6	4.7	.0	.0
Terre Haute	575	96	129	29.48	30.11		54.8		81	31	65	34	25	45	29	47	42	70	1.52	−1.2	7	6,738	s.	30	s.	21	13	10	8	4.5	.0	.0
Cincinnati	627	11	51	29.44	30.13	+.05	54.8	−.9	81	31	65	32	26	44	34	47	43	72	1.40	−1.1	6	5,005	sw.	23	nw.	24	15	5	11	5.0	.0	.0
Columbus	822	216	230	29.24	30.13	+.05	53.6	−1.6	78	31	63	31	26	44	32	46	41	70	1.20	−1.3	6	7,567	s.	35	nw.	24	9	13	9	5.2	.0	.0
Elkins	1,947	59	67	28.10	30.19	+.09	50.4	−1.9	81	1	63	20	26	38	44	44	42	84	1.99	−.9	10	3,920	s.	26	nw.	24	8	8	15	6.3	.0	.0
Parkersburg	637	77	82	29.50	30.16	+.08	55.0	−1.1	83	21	67	28	26	43	41	48	44	75	.51	−2.0	6	4,150	se.	27	nw.	24	10	11	10	5.3	.0	.0
Pittsburgh	842	353	410	29.22	30.14	+.06	53.8	−1.9	78	21	63	28	26	44	35	46	41	69	.46	−2.1	6	6,412	sw.	35	nw.	24	10	11	10	5.5	T	.0
Lower Lake Region							50.6	−1.5										69	1.67	−1.2										5.8		
Buffalo	767	243	280	29.24	30.08	+.03	50.5	−1.4	74	16	58	28	26	43	30	44	40	72	1.62	−1.7	14	10,927	sw.	54	sw.	19	8	11	12	5.9	T	.0
Canton	448	10	61	29.59	30.08		44.6	−2.6	72	16	54	14	26	35	33				2.58	−.4	11	6,702	sw.	29	sw.	22	5	12	14	6.5	6.3	.0
Ithaca	836	74	100	29.19	30.11		48.8	−2.3	78	1	59	24	29	39	32	43	39	73	1.84	−1.2	11	7,294	nw.	30	nw.	25	6	8	17	6.9	T	.0
Oswego	335	71	85	29.72	30.09	+.04	49.4	−1.8	71	1	57	26	29	42	31	44	38	68	2.22	−1.1	10	7,614	s.	29	nw.	25	6	8	17	6.7	T	.0
Rochester	523	86	102	29.53	30.11	+.06	50.2	−1.3	76	15	58	27	26	42	32	44	38	66	1.41	−1.2	8	6,146	sw.	24	w.	17	5	10	16	6.9	T	.0
Syracuse	596	65	79	29.47	30.12	+.06	50.0	−1.0	75	1	59	26	29	41	32				2.12	−.7	10	5,682	s.	26	nw.	25	8	9	14	6.2	T	.0
Erie	714	130	166	29.31	30.09	+.04	52.5	−.9	76	1	60	27	26	45	29	46	41	70	2.31	−1.4	12	9,757	s.	36	s.	16	12	10	9	5.2	1.2	.0
Cleveland	762	267	337	29.27	30.10	+.04	53.4	−.2	76	21	60	32	26	46	29	46	39	63	.97	−1.8	7	10,204	s.	49	w.	24	10	7	14	5.8	T	.0
Sandusky	629	5	67	29.42	30.12	+.06	52.9	−1.4	78	21	62	28	26	43	31				.94	−1.5	6	6,653	sw.	27	nw.	24	8	12	11	5.6	.0	.0
Toledo	628	79	87	29.42	30.11	+.06	51.6	−1.8	78	31	60	28	28	43	29	45	40	70	1.03	−1.3	6	6,582	sw.	27	nw.	24	15	8	8	4.3	.0	.0
Fort Wayne	857	69	84	29.17	30.11		51.0	−2.7	78	31	60	31	25	42	28	45	40	72	1.58	−1.0	8	6,366	w.	30	nw.	24	10	15	6	4.7	.0	.0
Detroit	730	218	258	29.30	30.10	+.05	52.2	−.3	79	31	60	29	28	44	25	45	40	70	1.45	−.9	8	7,031	sw.	27	sw.	19	12	8	11	5.3	.0	.0
Upper Lake Region							46.6	−1.9										77	3.35	+.6										6.4		
Alpena	609	13	89	29.37	30.04	+.01	45.8	−1.3	74	15	54	21	28	38	27	42	38	79	3.11	+.4	13	8,382	nw.	37	s.	19	2	13	16	7.3	2.0	.0
Escanaba	612	54	60	29.35	30.02	+.01	44.4	−1.6	65	2	52	19	28	37	24	40	37	78	2.32	−.3	12	8,442	s.	32	n.	24	4	9	18	7.3	2.2	.0
Grand Rapids	707	70	244	29.30	30.08	+.04	50.0	−1.2	78	31	58	27	28	42	33	44	39	72	4.67	+1.9	11	8,647	s.	41	sw.	19	8	13	10	5.5	T	.0
Lansing	878	6	88	29.13	30.09		47.4	−2.9	76	31	57	22	28	38	37	43	41	88	3.41	+.9	10	6,777	s.	32	sw.	21	11	9	11	5.6	T	.0
Ludington	637	60	66	29.34	30.03		48.2	−1.5	69	15	54	24	28	42	24	44			3.83	+.9	10		sw.				7	10	14		1.0	.0
Marquette	734	77	111	29.19	30.00	−.01	43.8	−2.9	68	14	50	19	28	38	25	40	36	80	2.06	−.7	19	8,428	w.	32	sw.	14	1	10	20	7.9	6.4	.0
Sault Ste. Marie	614	11	52	29.32	30.03	+.02	43.0	−1.6	66	15	49	16	28	37	25	40	36	80	3.93	+.2	19	6,874	se.	31	nw.	27	2	9	20	8.1	6.0	.0
Chicago	673	7	131	29.36	30.08	+.04	52.8	−1.2	78	31	60	32	25	45	24	46	40	69	3.64	+1.1	7	7,937	sw.	33	nw.	24	13	7	11	5.0	T	.0
Green Bay	617	109	141	29.35	30.02	.00	46.4	−2.1	73	30	55	24	28	38	33	41	37	75	3.59	+1.0	10	8,922	s.	38	ne.	7	8	6	17	6.6	3.8	.0
Milwaukee	681	97	221	29.31	30.05	+.02	50.3	−.8	78	31	58	27	25	42	33	44	39	70	2.83	+.5	8	10,044	w.	40	sw.	19	13	8	10	4.7	T	.0
Duluth	1,133	5	47	28.76	30.00	.00	40.7	−3.4	72	14	49	10	27	32	30	36	33	81	3.43	+1.1	12	7,440	w.	34	nw.	27	5	14	12	6.2	14.0	T
North Dakota							41.5	−2.3										65	.64	−.5										5.5		
Moorehead	940	50	58	28.99	30.03	+.03	42.6	−1.9	83	14	54	15	27	31	47	35	28	62	.45	−1.2	5	7,466	n.	30	w.	21	6	14	11	5.8	.6	.0
Bismarck	1,674	8	57	28.22	30.03	+.04	43.4	−1.5	78	13	56	17	12	30	43	36	28	63	.44	−.5	5	7,145	nw.	35	w.	20	10	12	9	5.3	3.7	.0
Devils Lake	1,478	11	44	28.43	30.04	+.05	38.2	−4.2	75	14	50	9	27	27	38	32	25	69	.62	−.6	6	7,691	nw.	30	w	21	8	9	14	6.0	2.4	.0
Grand Forks	833	12	67				39.4		82	14	51	11	24	28	49	33			1.33		6		nw.	40	w.	21	4	13	14		4.4	.0
Williston	1,878	41	48	28.02	30.03	+.05	41.8	−1.6	82	4	53	18	22	31	39	35	28	67	1.05	+.2	7	6,258	se.	38	w.	20	14	6	11	4.9	4.1	.0
Upper Mississippi Valley							51.9	−1.4										71	1.98	−.5										4.8		
Minneapolis	918	102	208	29.02	30.01		47.4	−1.5	78	31	56	22	27	38	32	41	33	61	1.26	−.8	5	9,003	s.	30	n.	24	9	10	12	5.8	.3	.0
La Crosse	714	11	48	29.25	30.03	+.01	48.0	−2.3	79	31	58	23	25	38	36	42	38	75	1.75	−.6	8	4,610	s.	18	nw.	24	9	12	10	5.7	.1	.0
Madison	974	70	78	28.99	30.05	+.02	49.0	−1.3	77	31	57	26	25	41	27	43	38	70	1.48	−1.0	10	7,015	s.	25	nw.	24	12	10	9	5.1	.3	.0
Charles City	1,015	10	51	28.97	30.07	+.05	47.0	−1.6	78	30	58	22	25	36	38	40	36	72	2.01	−.3	6	5,687	se.	22	n.	24	12	11	8	4.4	.1	.0
Davenport	606	118	143	29.42	30.08	+.04	52.4	−1.3	79	31	62	27	25	43	27	45	40	71	1.72	−.7	9	7,099	nw.	30	nw.	24	13	6	12	5.2	T	.0
Des Moines	861	5	99	29.16	30.07	+.04	51.0	−2.4	79	30	62	26	25	40	39	44	39	70	3.15	+.6	4	7,052	nw.	25	nw.	16	14	10	7	4.1	T	.0
Dubuque	700	81	96	29.30	30.06	+.02	49.8	−2.1	79	31	59	26	25	40	32	43	38	69	.97	−1.5	9	5,380	s.	26	nw.	24	13	8	10	4.8	.0	.0
Keokuk	614	64	78	29.43	30.11	+.06	54.2	−1.2	80	30	64	30	25	44	29	46	40	67	1.07	−1.2	9	5,675	sw.	26	nw.	16	16	6	9	4.4	.0	.0
Cairo	358	87	93	29.71	30.10	+.03	59.6	−.8	83	31	69	38	25	50	27	52	48	75	2.75	.0	9	5,865	s.	30	n.	24	13	6	12	5.0	.0	.0
Peoria	609	11	45	29.44	30.11	+.06	51.8	−.2	80	30	63	29	25	41	33	45	42	78	2.23	−.1	11	4,322	s.	20	nw.	24	16	4	11	4.0	.0	.0
Springfield, Ill	636	5	191	29.41	30.10	+.05	54.7	−1.1	81	31	65	31	25	45	31	47	43	74	2.38	−.2	8	8,127	s.	32	s.	21	14	8	9	4.7	.0	.0
St. Louis	568	265	303	29.48	30.09	+.03	57.4	−.9	82	31	67	34	25	48	34	50	45	68	2.97	+.2	11	8,695	s.	38	sw.	21	14	11	6	4.2	.0	.0
Missouri Valley							54.6	+0.2										60	.99	−1.3										3.5		
Columbia, Mo	784	6	84	29.26	30.10	+.05	55.8	−.8	80	31	66	30	25	45	32				2.97	+.4	9	5,861	s.	24	nw.	7	17	6	8	4.1	.0	.0
Kansas City	963	10	86	29.07	30.09	+.05	58.0	+.3	80	4	68	32	25	48	30	49	42	60	.58	−2.3	5	1,765	s.	32	w.	7	16	11	4	3.9	.0	.0
St. Joseph	967	11	49	29.04	30.08		55.8		80	4	68	30	25	44	36	47	41	65	.79	−1.9	3	5,944	s.	24	nw.	7	19	9	3	2.7	.0	.0
Springfield, Mo	1,324	98	104	28.68	30.09	+.04	57.6	−.6	79	11	67	34	25	48	32	50	45	70	3.17	+.1	10	7,218	se.	23	s.	21	19	9	3	2.9	.0	.0
Iola	984	11	50	29.03	30.07	+.03	58.4	+.6	81	5	70	32	25	46	34				2.03	−1.0	6		s.				14	8	9		.0	.0
Topeka	987	65	87				57.0	.0	83	4	69	31	25	45	35				.61	−1.8	4	6,639	s.	26	nw.	7	18	8	5	3.2	.0	.0
Lincoln	1,189	11	81	28.79	30.06	+.03	53.8	−.4	82	30	66	28	25	41	40	46	38	62	.09	−1.8	1	7,176	s.	30	s.	28	14	15	2	3.5	.0	.0
Omaha	1,105	115	122	28.88	30.08	+.05	53.8	−.5	81	30	65	29	25	43	42	45	37	57	.36	−1.8	3	6,181	s.	29	nw.	24	19	10	2	2.9	T	.0
Valentine	2,598	47	54	27.32	30.06	+.05	51.6	+2.3	87	29	67	16	22	36	51	39	29	51	.05	−1.0	2	7,346	w.	37	s.	20	18	9	4	3.5	.0	.0
Sioux City	1,135	94	164	28.82	30.05	+.03	51.5	+.6	82	14	63	26	25	40	42	42	34	58	.22	−1.6	3	9,052	s.	34	nw.	19	16	10	5	3.8	T	.0
Huron	1,306	59	74	28.64	30.05	+.04	48.2	+.5	85	29	62	22	25	35	52	39	29	56	.05	−1.2	1	7,829	se.	31	n.	15	14	12	5	4.1	.5	.0
Northern Slope							49.0	+3.7										57	.68	−.4										4.4		
Billings	3,140	5					50.5		87	4	68	21	21	33	55				.44		3		nw.				10	15	16		.0	.0
Havre	2,505	11	67	27.36	30.02	+.04	44.4	−.1	84	4	56	19	21	33	45	37	32	69	.84	+.2	7	6,357	w.	32	w.	13	9	10	12	5.7	2.2	.0
Helena	4,124	85	111	25.81	30.01	−.02	48.8	+3.9	77	8	60	24	24	38	37	40	33	61	1.01	+.1	9	5,408	sw.	33	sw.	18	11	9	11	5.4	3.3	.0
Kalispell	2,973	48	56	26.95	30.03	+.02	45.6	+2.1	71	13	56	28	17	36	35	41	37	76	2.70	+1.6	12	3,969	nw.	23	sw.	14	10	6	15	6.1	9.5	.0
Miles City	2,371	48	55	27.49	30.06	+.06	48.6	+2.1	86	4	62	23	21	36	42	39	31	60	.39	−.5	6	4,576	s.	32	nw.	20	13	11	7	4.7	.0	.0
Rapid City	3,259	50	58	26.63	30.06	+.05	51.3	+2.8	83	13	65	25	22	37	46	41	31	51	.17	−.8	3	6,062	w.	35	nw.	20	14	11	6	4.0	.0	.0
Cheyenne	6,088	84	101	24.06	30.00	−.01	51.0	+6.2	74	30	65	24	16	37	42	38	26	42	T	−1.0	0	8,511	w.	39	w.	28	17	9	5	3.5	T	.0
Lander	5,372	60	68	24.68	30.02	−.02	50.6	+7.1	75	7	68	18	21	33	43	38	26	44	.01	−1.4	1	4,231	sw.	46	sw.	20	22	8	1	2.1	.0	.0
Sheridan	3,790	10	47	26.12	30.03		49.4		85	4	66	23	21	33	52	38	30	62	.83	−.2	9	3,962	nw.	32	nw.	20	16	8	7	4.3	T	.0
Yellowstone Park	6,241	11	48	23.95	30.07	+.05	46.2	+4.7	76	7	60	17	21	32	46	35	25	51	.83	−.6	7	6,200	sw.	31	sw.	31	14	6	11	4.7	.3	.0
North Platte	2,821	11	51	27.11	30.04	+.02	54.2	+4.5	84	14	70	29	9	39	53	42	34	57	T	−1.1	0	5,041	s.	27	n.	20	17	9	5	3.6	.0	.0

TABLE 1.—*Climatological data for Weather Bureau Stations, October, 1933*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	Pct.	In.	In.		Miles								0-10	In.	In.
Middle Slope							58.7	+2.8										53	.90	-.8												
Denver	5,292	106	113	24.78	30.00	-.01	57.4	+6.2	80	29	71	31	22	43	38	42	27	36	.01	-1.0	1	5,641	s.	27	n.	5	17	13	1	2.8	.0	.0
Pueblo	4,685	80	86	25.35	30.02	+.03	56.6	+4.6	83	30	74	28	22	39	51	41	27	39	.00	-.7	0	4,642	se.	21	w.	28	20	10	1	3.2	.0	.0
Concordia	1,392	50	58	28.61	30.10	+.07	56.2	+.3	81	30	69	28	25	43	36	46	39	60	.06	-1.9	1	6,051	s.	26	s.	31	15	15	1	3.2	.0	.0
Dodge City	2,509	10	86	27.47	30.07	+.05	58.6	+2.5	80	11	72	32	25	45	40	47	39	57	1.27	.0	4	8,588	s.	30	ne.	24	22	8	1	2.2	.0	.0
Wichita	1,358	85	93	28.62	30.05	+.02	60.0	+1.4	84	5	70	35	25	50	32	50	42	59	.74	-1.8	3	7,698	s.	27	ne.	24	15	10	6	4.1	.0	.0
Oklahoma City	1,214	10	47	28.77	30.05	+.02	63.3	+1.8	85	10	74	41	25	53	32	54	49	69	3.34	+.5	7	6,645	s.	28	nw.	11	13	14	4	4.0	.0	.0
Southern Slope							68.2	+5.0										60	.60	-1.2										2.8		
Abilene	1,738	10	52	28.22	30.01	.00	71.1	+5.7	93	21	84	49	17	59	36	58	51	59	.39	-2.1	2	6,763	s.	25	sw.	19	10	10	2	2.6	.0	.0
Amarillo	3,676	10	49	26.32	30.02	+.02	62.4	+4.7	86	29	76	38	22	49	41	50	42	57	.49	-1.2	2	6,831	s.	19	s.	30	20	9	2	3.1	.0	.0
Big Spring	2,537	5	62	27.40	30.00	------	68.8	------	90	24	82	44	17	56	40	56	50	64	.45		3	------	s.	------	------	------	23	5	3	2.5	.0	.0
Del Rio	944	64	71	28.97	29.95	-.03	75.4	+5.4	91	7	85	59	5	66	28	64	59	66	1.43	-.4	5	5,817	se.	24	e.	1	13	13	5	4.2	.0	.0
Roswell	3,566	75	85	26.41	29.99	+.03	63.7	+4.2	86	29	79	39	17	49	44	50	41	53	.09	-1.3	3	4,736	n.	24	w.	14	25	5	1	1.8	.0	.0
Southern Plateau							65.7	+5.7										53	.61	.0										2.3		
El Paso	3,778	152	175	26.22	29.95	+.03	68.6	+5.1	86	22	80	50	18	57	32	54	44	48	.60	-.2	7	5,900	nw.	29	e.	1	23	4	4	2.4	.0	.0
Albuquerque	4,972	51	66	25.12	29.98	------	58.2	------	79	24	74	34	22	42	44	45	36	54	.24	------	5	5,309	n.	29	nw.	14	19	7	5	2.9	.0	.0
Santa Fe	7,013	38	53	23.35	30.02	+.06	53.7	+3.3	72	24	66	36	27	41	32	41	32	53	1.16	.0	7	4,127	e.	18	ne.	14	20	5	6	3.2	.0	.0
Flagstaff	6,907	10	59	23.44	29.99	+.07	50.9	+6.2	74	2	66	26	22	36	43	42	------	70	2.19	------	11	5,282	n.	27	se.	31	10	12	9	------	.0	.0
Phoenix	1,108	10	107	28.75	29.89	+.01	76.8	+6.2	99	2	91	54	18	63	40	59	48	42	.38	-.1	5	4,229	e.	23	ne.	5	23	7	1	1.9	.0	.0
Yuma	141	9	54	29.71	29.85	-.02	79.2	+5.9	105	3	94	55	28	64	41	63	54	50	.78	+.5	1	3,386	ne.	22	se.	6	28	3	0	1.0	.0	.0
Independence	3,957	5	26	26.02	30.03	+.08	64.8	+7.3	91	3	80	39	24	49	40	46	------	------	.11	-.2	2	------	n.	------	------	------	24	3	4	------	.0	.0
Middle Plateau							57.5	+7.2										38	.86	.0										2.4		
Reno	4,532	74	81	25.52	29.99	.00	59.6	+9.9	89	2	77	32	31	42	43	44	29	38	1.65	+1.3	2	4,704	sw.	31	sw.	28	21	8	2	2.4	T	.0
Tonopah	6,090	12	20	------	------	------	59.8	------	79	2	69	32	31	50	27	43	24	27	T	------	0	------	se.	------	------	------	------	------	------	------	------	------
Winnemucca	4,344	18	56	25.68	30.06	+.01	55.1	+6.8	86	2	76	22	21	35	53	40	24	36	1.07	+.4	1	5,473	ne.	24	w.	30	25	4	2	2.0	T	.0
Modena	5,473	10	46	24.68	29.99	+.03	55.2	+7.2	78	24	72	29	17	39	46	42	29	45	.62	-.1	5	6,917	sw.	35	sw.	31	20	6	5	2.9	T	.0
Salt Lake City	4,360	86	210	25.68	30.02	+.01	58.8	+6.3	79	4	72	33	31	46	34	44	29	36	.66	-.8	1	5,312	se.	31	se.	30	21	7	3	2.4	.4	T
Grand Junction	4,602	60	68	25.43	30.01	+.02	58.7	+5.9	84	1	74	34	28	44	39	44	32	44	.32	-.6	3	4,065	se.	24	s.	31	24	4	3	2.4	.0	.0
Northern Plateau							55.0	+5.4										53	1.12	.0										4.3		
Baker	3,471	48	53	26.50	30.09	+.01	51.8	+5.2	83	6	67	20	21	37	44	43	36	60	.44	-.5	7	5,035	se.	22	w.	19	14	10	7	3.9	T	.0
Boise	2,739	79	87	27.22	30.07	+.01	56.4	+5.3	84	6	71	24	21	42	38	45	32	44	.88	-.4	3	3,607	se.	25	nw.	20	17	7	7	3.6	.0	.0
Pocatello	4,477	60	68	25.53	30.04	.00	55.6	+7.2	81	7	70	30	1	41	43	41	26	37	.21	-1.0	1	7,044	se.	30	sw.	31	17	10	4	3.3	T	.0
Spokane	1,929	101	110	27.97	30.02	+.04	51.7	+3.4	81	7	63	28	21	40	38	45	39	66	2.72	+1.6	9	4,424	sw.	21	W.	19	10	6	15	5.7	2.6	.0
Walla Walla	991	57	65	28.95	30.02	-.05	58.8	+5.3	81	8	69	37	21	49	31	49	41	54	2.05	+.5	8	4,144	s.	25	sw.	16	13	6	12	5.0	.0	.0
Yakima	1,076	58	67	28.86	30.02	------	55.9	+5.7	85	7	69	27	21	42	40	47	38	56	.45	-.2	6	3,758	nw.	26	sw.	16	13	9	9	4.4	.0	.0
North Pacific Coast Region							54.3	+1.9										78	4.26	+.4										6.0		
North Head	211	11	56	29.82	30.05	.00	52.7	-.2	74	3	57	42	19	49	26	50	49	90	5.43	+.4	16	10,394	n.	49	s.	22	7	4	20	7.2	.0	.0
Seattle	125	90	321	29.90	30.03	-.02	54.0	+2.6	74	6	60	40	21	48	26	50	47	81	3.16	+.3	14	7,027	s.	40	s.	22	6	7	18	6.9	.0	.0
Tatoosh Island	86	10	54	29.92	30.02	+.01	50.8	+.9	66	3	54	43	21	48	12	49	48	91	10.03	+1.9	16	10,049	e.	44	s.	28	9	2	20	6.9	.0	.0
Medford	1,329	29	58	28.62	30.02	------	57.4	------	95	6	75	26	21	40	53	48	39	58	1.13	-.2	5	3,396	s.	20	nw.	29	18	5	8	4.0	.0	.0
Portland, Oreg.	153	68	106	29.88	30.04	-.02	57.2	+3.0	81	3	65	38	21	49	29	53	49	77	4.59	+1.5	13	4,476	nw.	22	sw.	22	9	8	14	6.2	.0	.0
Roseburg	510	75	99	29.50	30.06	-.02	57.0	+3.1	89	3	70	30	21	43	41	51	46	71	1.22	-1.4	7	2,630	nw.	21	w.	19	11	10	10	5.0	.0	.0
Middle Pacific Coast Region							63.7	+3.4										66	1.43	.0										4.2		
Eureka	62	73	89	29.90	30.06	.00	52.8	-.8	66	29	58	43	22	48	17	51	50	93	2.08	-.2	10	4,084	n.	22	s.	30	5	8	18	7.2	.0	.0
Red Bluff	330	5	58	29.58	29.93	-.10	71.2	+6.9	104	5	86	47	31	56	43	55	42	41	1.48	+.2	3	4,505	nw.	24	se.	30	21	6	4	2.8	.0	.0
Sacramento	69	106	117	29.87	29.94	-.05	68.4	+5.5	101	4	83	47	21	54	39	56	47	53	.66	-.3	3	4,990	s.	24	se.	30	26	3	2	1.5	.0	.0
San Francisco	155	208	243	29.81	29.98	-.03	62.4	+1.9	92	5	70	50	14	54	34	55	51	77	1.49	+.4	4	4,546	sw.	24	sw.	30	10	11	10	5.1	.0	.0
South Pacific Coast Region							66.8	+2.5										69	.34	-.2										3.6		
Fresno	327	97	105	29.59	29.94	-.02	71.4	+7.4	100	5	86	47	31	56	36	57	46	47	.53	.0	1	3,863	nw.	22	se.	30	24	5	2	1.8	.0	.0
Los Angeles	338	159	191	29.60	29.97	+.02	66.7	+1.4	100	4	76	51	22	58	34	58	53	74	.34	-.3	2	3,749	sw.	17	nw.	31	18	6	7	3.8	.0	.0
San Diego	87	62	70	29.85	29.95	.00	62.4	-1.3	79	17	68	51	17	57	28	58	56	85	.16	-.4	1	4,435	nw.	19	nw.	3	10	13	8	5.2	.0	.0
West Indies																																
San Juan, P.R.	82	9	54	29.79	29.87	------	80.4	+.6	92	7	86	73	23	75	16	------	------	------	2.64	-3.2	13	6,352	e.	29	e.	19	5	21	5	5.8	.0	.0
Panama Canal																																
Balboa Heights	118	6	97	------	[1] 29.82	.00	79.3	+.1	91	15	85	70	28	74	19	------	------	[1] 86	5.88	-4.2	19	5,630	nw.	32	s.	2	0	11	20	7.8	.0	.0
Cristobal	36	6	97	------	[1] 29.82	-.01	80.8	+1.0	90	30	86	73	26	75	16	75	74	[1] 81	19.84	+4.3	21	5,179	se.	26	nw.	26	3	9	19	7.3	.0	.0
Alaska																																
Fairbanks	454	68	87	[2] 29.36	[2] 29.90	------	20.2	------	47	2	28	-11	20	12	28	20	13	67	1.08	------	11	3,576	s.	17	n.	17	8	7	16	6.4	16.4	9.0
Juneau	80	11	50	[2] 29.80	[2] 29.89	------	38.5	------	55	3	42	13	22	35	17	36	31	73	14.09	------	22	7,549	se.	39	ne.	22	2	6	23	8.3	8.4	.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 29.98	[2] 30.02	------	75.6	-1.2	84	25	81	66	10	71	13	69	65	71	.06	-1.5	3	5,777	e.	21	e.	7	12	13	6	4.7	.0	.0

[1] Observations taken bihourly.

[2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service*

OCTOBER 1933

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	In.	In.	In.	°F.	°F.	°F.	°F.	°F.	°F.	In.	In.	In.
Cape Race, N.F.	99				48.9		54.9	43.0	62	26	4.03		0.0
Sydney, C.B.I.	48	30.00	30.05	+0.09	50.7	+4.2	58.8	42.6	71	29	11.18	+6.49	.0
Halifax, N.S.	88	29.77	29.88	−.12	49.6	+2.4	57.4	41.7	68	25	13.52	+7.97	.0
Yarmouth, N.S.	65												
Charlottetown, P.E.I.	38	29.96	30.00	+.04	49.7	+3.2	55.9	43.5	66	29	4.62	−.28	.0
Chatham, N.B.	28	29.92	29.95	−.01	46.3	+3.3	56.6	36.0	72	20	8.94	+5.08	.0
Father Point, Que.	20	29.99	30.02	+.07	41.5	+1.7	47.5	35.5	64	24	1.78	−1.12	6.4
Quebec, Que.	296	29.76	30.09	+.09	44.7	+2.3	50.1	39.3	65	22	3.25	+.10	3.4
Doucet, Que.	1,236				35.7		44.2	27.2	68	−5	3.10		7.1
Montreal, Que.	187												
Ottawa, Ont.	236	29.81	30.08	+.07	46.0	+2.2	55.3	36.7	71	14	2.10	−.45	10.5
Kingston, Ont.	285	29.77	30.08	+.05	48.4	+1.4	55.4	41.4	66	19	1.76	−.97	T
Toronto, Ont.	379	29.67	30.08	+.04	47.8	+1.2	55.3	40.3	69	22	2.26	−.10	.0
Cochrane, Ont.	930												
White River, Ont.	1,244	28.65	29.99	+.01	35.2	−1.9	42.5	27.8	59	−6	3.66	+1.31	19.2
London, Ont.	808				47.4		57.0	37.8	73	21	2.42		.0
Southampton, Ont.	656	29.33	30.05	+.03	47.3	+1.2	55.1	39.5	72	20	3.67	+.50	2.8
Parry Sound, Ont.	688	29.34	30.04	+.03	45.6	+1.7	52.0	39.3	68	19	5.87	+1.95	4.2
Port Arthur, Ont.	644	29.28	29.99	+.01	39.6	−.3	46.5	32.8	57	8	2.37	−.19	4.7
Winnipeg, Man.	760	29.17	30.02	+.04	36.3	−2.8	45.3	27.3	73	14	.67	−1.03	
Minnedosa, Man.	1,690	28.18	30.04	+.07	33.7	−4.1	44.4	23.0	70	6	2.15	+.95	20.2
Le Pas, Man.	860				32.1		40.6	23.6	67	3	1.83		12.2
Qu'Appelle, Sask.	2,115	27.69	29.98	+.01	35.6	−3.8	45.6	25.5	77	7	.82	−.28	7.0
Moose Jaw, Sask.	1,759				38.0		49.1	27.0	82	4	1.24		10.2
Swift Current, Sask.	2,392	27.41	29.97	.00	38.9	−3.2	49.7	28.2	80	4	.91	+.03	8.8
Medicine Hat, Alb.	2,365	27.43	29.93	−.04	41.3	−3.5	52.4	30.2	84	9	1.85	+1.27	16.0
Calgary, Alb.	3,540	26.25	29.97	+.02	36.6	−3.5	46.8	26.5	85	55	1.29	+.81	12.7
Banff, Alb.	4,521												
Prince Albert, Sask.	1,450	28.46	30.07	+.10	36.3	−.8	46.3	26.3	73	8	.99	+.16	8.7
Battleford, Sask.	1,592	28.25	30.02	+.05	35.8	−3.8	47.2	24.5	80	6	1.32	+.87	8.8
Edmonton, Alb.	2,150												
Kamloops, B.C.	1,262	28.72	30.03	+.07	45.9	−1.1	54.6	37.3	73	28	2.39	+1.78	11.7
Victoria, B.C.	230	29.76	30.02	+.01	51.5	+2.3	57.0	46.0	72	40	4.98	+2.61	.0
Barkerville, B.C.	4,180												
Estevan Point, B.C.	20				48.9		53.5	44.3	62	36	17.44		.0
Prince Rupert, B.C.	170												
Hamilton, Ber.	151	29.86	30.03	+.01	76.0	+3.0	80.7	71.3	86	65	4.76	−1.95	.0
LATE REPORTS FOR SEPTEMBER, 1933													
Cape Race, N.F.	99				52.6		58.5	46.6	67	34	2.94		0.0
Father Point, Que.	20	29.79	29.81	−0.17	48.6	−1.8	55.3	42.0	70	34	4.02	+0.89	.0
Cochrane, Ont.	930				51.7						2.17		.0
Moose Jaw, Sask.	1,759				55.5		67.3	43.7	83	28	1.06		.0
Banff, Alb.	4,521	25.26	29.79	−.14	46.0	+.2	54.6	37.5	69	27	.81	−.86	.2
Battleford, Sask.	1,592	28.04	29.75	−.15	51.6	−.2	61.7	41.4	81	23	2.58	+1.33	.0
Edmonton, Alb.	2,150	27.49	29.74	−.16	49.2	−.1	60.0	38.3	84	25	1.86	+.53	.8

SEVERE LOCAL STORMS, OCTOBER 1933

[Compiled by Mary O. Souder]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Harrisburg, Pa	1	P.m.				Thunderstorm	Power lines struck at 2 different points in the city; minor damage.	Official, U.S. Weather Bureau.
Miami, Fla	4-5	12 p.m.	60		$5,000	Tornado	4 houses blown down and several others unroofed; wires down, causing loss to system of several thousand dollars; path 1 mile long.	Do.
Key West, Fla	4-5					Hurricane	Electric service suspended; number of shade trees uprooted; several small boats blown ashore; city flooded.	Do.
Fort Lauderdale, Fla	5	1-2 a.m.				Tornado	Several trees uprooted; windows broken; 1 person injured.	Do.
Hollywood, Fla	5	do				do	Power lines of the Florida Power & Light Co., wires of the Western Union Telegraph Co., and the semaphore system of the Florida East Coast Railway out of commission; several buildings damaged; large groups of persons went to the courthouse for the night, while others registered at down-town hotels; classes in all public schools of the county were suspended for 2 days.	Do.
Wickenburg, Ariz	6					Heavy rain	Traffic delayed when flooding caused the destruction of a highway bridge.	Do.
Indianapolis, Ind	8	1:30 p.m				Heavy hail and rain.	No damage reported	Do.
Somerton-Gadsden, Ariz	9	P.m.				Wind, hail and rain.	Wind and hail stripped cotton from several hundred acres; loss to poultry and vegetable crop; streets in Somerton flooded.	Do.
Big Spring, Tex., 13 miles north	10	5:25 p.m		1		Thunderstorm	Man killed by lightning while standing in front of a parked car on the highway.	Do.
Omego, Okla	12	7:30-9:30 p.m.	[1] 3		23,000	Hail	Severe loss to crops, especially cotton; $3,000 damage to buildings; path 6 miles long.	Do.
Sayre, Okla., 8 miles southeast	14	9:30 p.m	100	3	3,000	Tornado	A person injured when a residence was demolished; damage to other property estimated at $3,000.	Do.
Bokchito, Brown, and Colbert, Okla.	15	4-6 p.m	[1] ¼-4		20,000	Heavy hail and wind.	Loss to crops; property damaged; path from 1 to 10 miles long.	Do.
Brown, Okla	15		50			Tornado	4 homes, several barns and a number of small buildings demolished; everything in storm path destroyed; no estimate given; path 1 mile long.	Do.
Milwaukee, Wis., and vicinity	19					Wind and gale	Trees and wires blown down; 1 person injured	Do.
Chattanooga-Faxon, Okla., and vicinity.	20	10 p.m	[1] 4½		2,500	Hail	Damage principally to cotton crop; path 10 miles long.	Do.
Pensacola, near, Fla	20				25,000	Wind	Barge with cargo sunk	Do.
Terre Haute, Ind	21	8:20 p.m				Thundersquall	Trees blown down; damage slight	Do.
Chicago, Ill	21	P. m				Heavy rain	Traffic delayed; streets, viaducts, and basements flooded.	Do.
South Bend, Ind., few miles north.	21				5,000	Wind	Damage to buildings reported	Do.
Flint, Mich., and vicinity	21	P.m				Gale and rain	At midnight many streets in the northeastern section of the city were impassable; some basements flooded as high as 6 feet; several thousand dollars' loss reported.	Do.
Southwestern Michigan	21-22			2		Thundersqualls and hail.	Damage to farm buildings; 2 persons killed by lightning.	Do.
Canton, N.Y	24-25					Heavy snow	Considerable damage to telephone and electric lines; trees broken; snow was sticky, but because of its freezing it remained for several days.	Do.
Northern Vermont	24-25					Snow, glaze, and wind.	Barre, Montpelier, and vicinity, had 12 inches of snow; 1,000 to 1,500 poles down; communication by train and automobile only; roads dangerously icy causing automobiles to skid on practically every main highway; many cars stuck; 1 out-of-town car was seen completely covered with a thick layer of ice; worst storm in October in 40 years.	Do.
Lutherville, Ark	26				1,000	Electrical	Barn and contents destroyed by lightning	Do.

[1] Miles instead of yards.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, October 1933

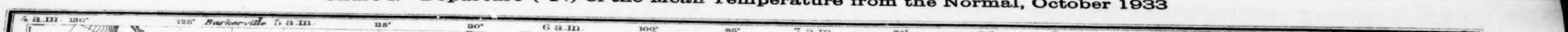


Chart I. Departure (°F.) of the Mean Temperature from the Normal, October 1933

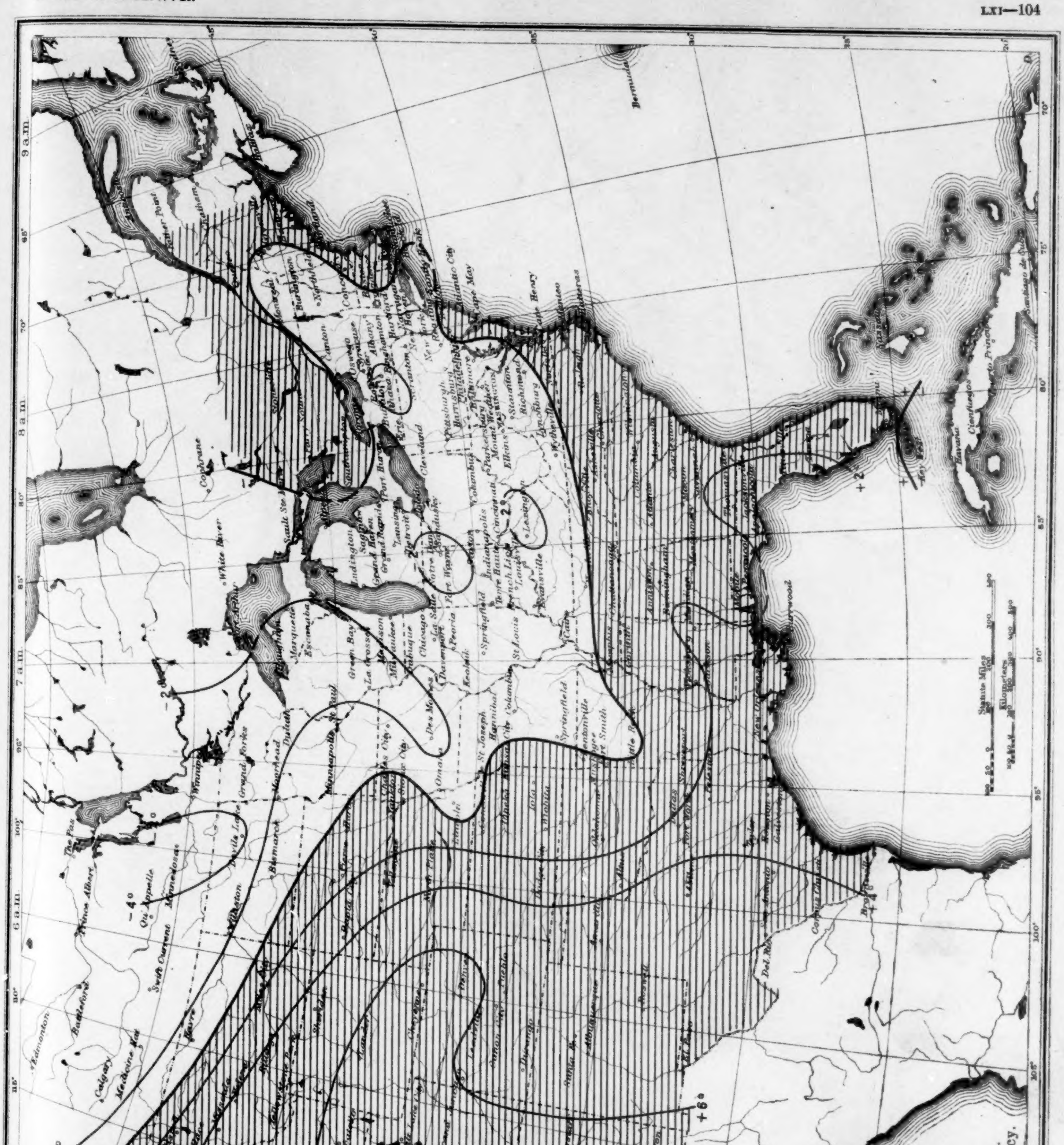
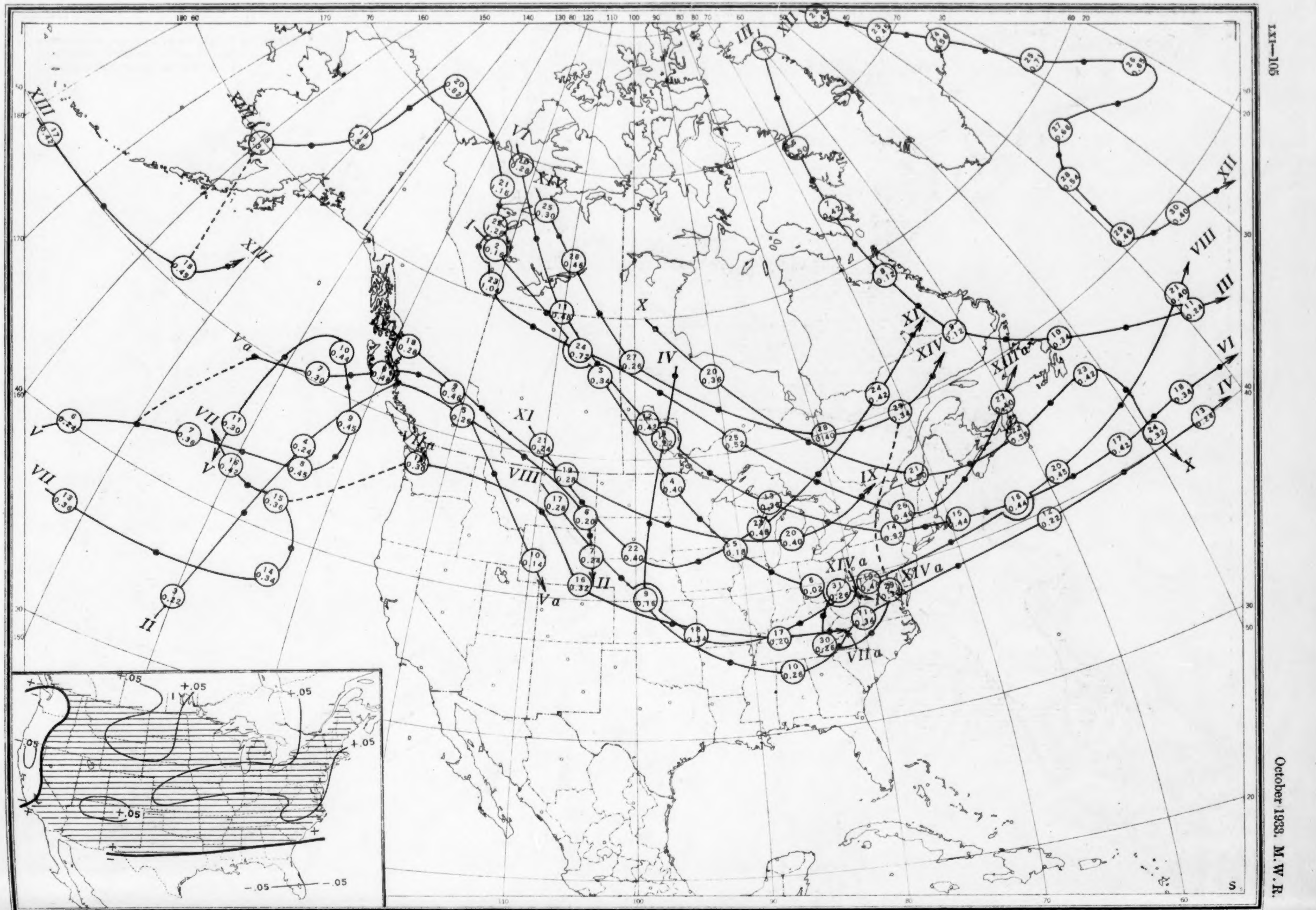


Chart II. Tracks of Centers of Anticyclones, October 1933. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by G. E. Dunn)

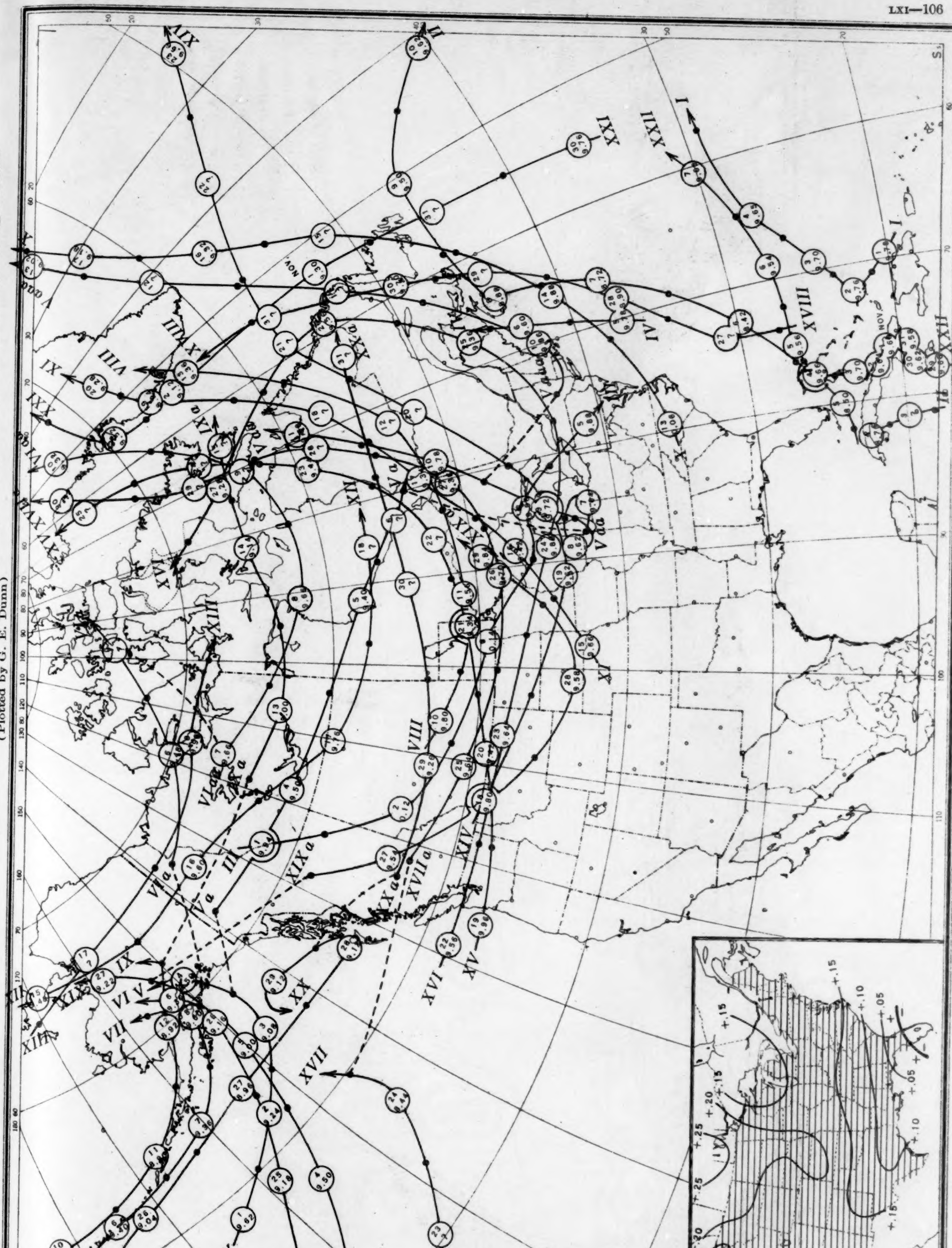


Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, October 1933. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by G. E. Dunn)

Chart III. Tracks of Centers of Cyclones, October 1933. (Inset) Change in Mean Pressure from Preceding Month
(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky between Sunrise and Sunset, October 1933

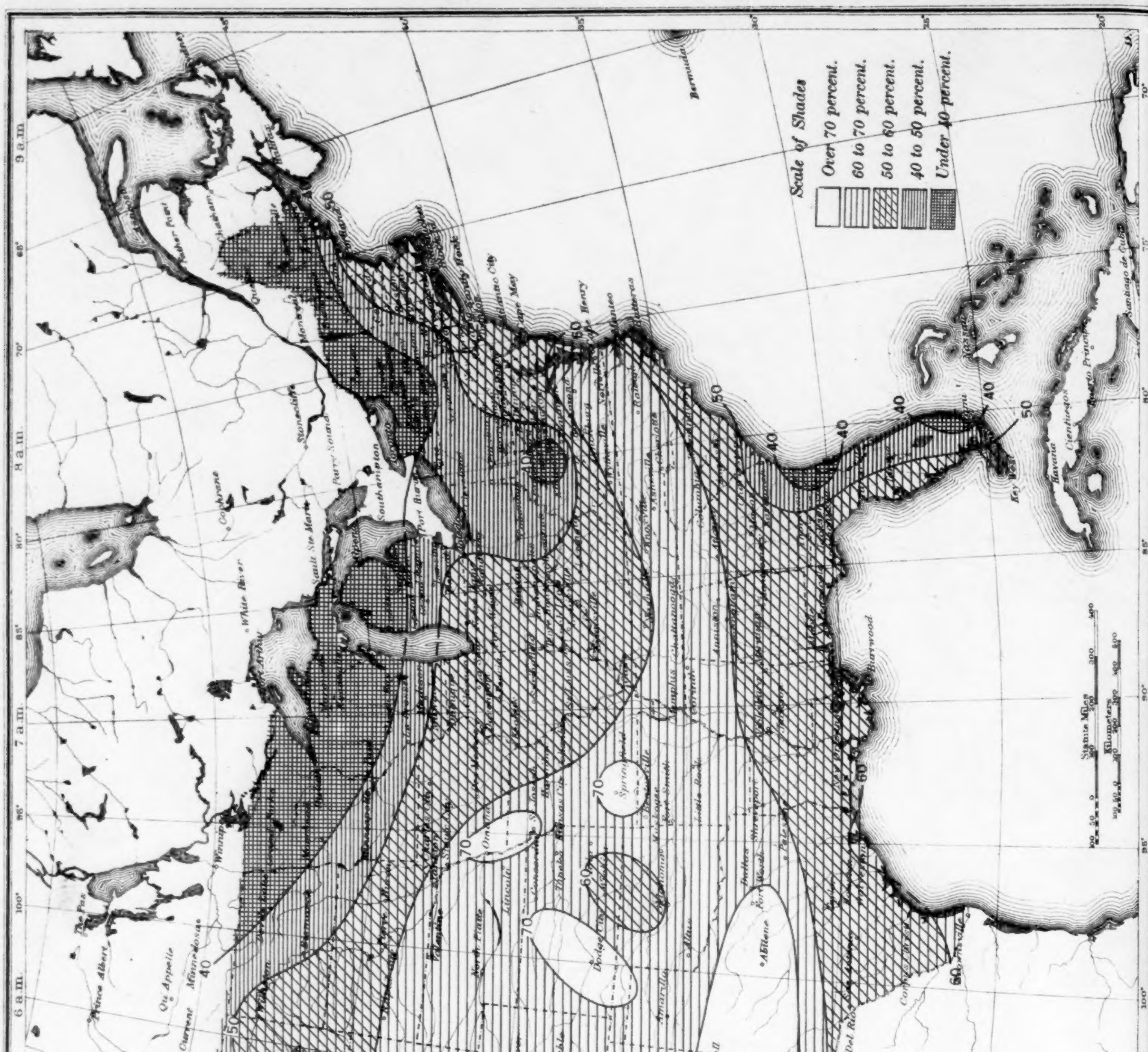


Chart V. Total Precipitation, Inches, October 1933. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, October 1933. (Inset) Departure of Precipitation from Normal

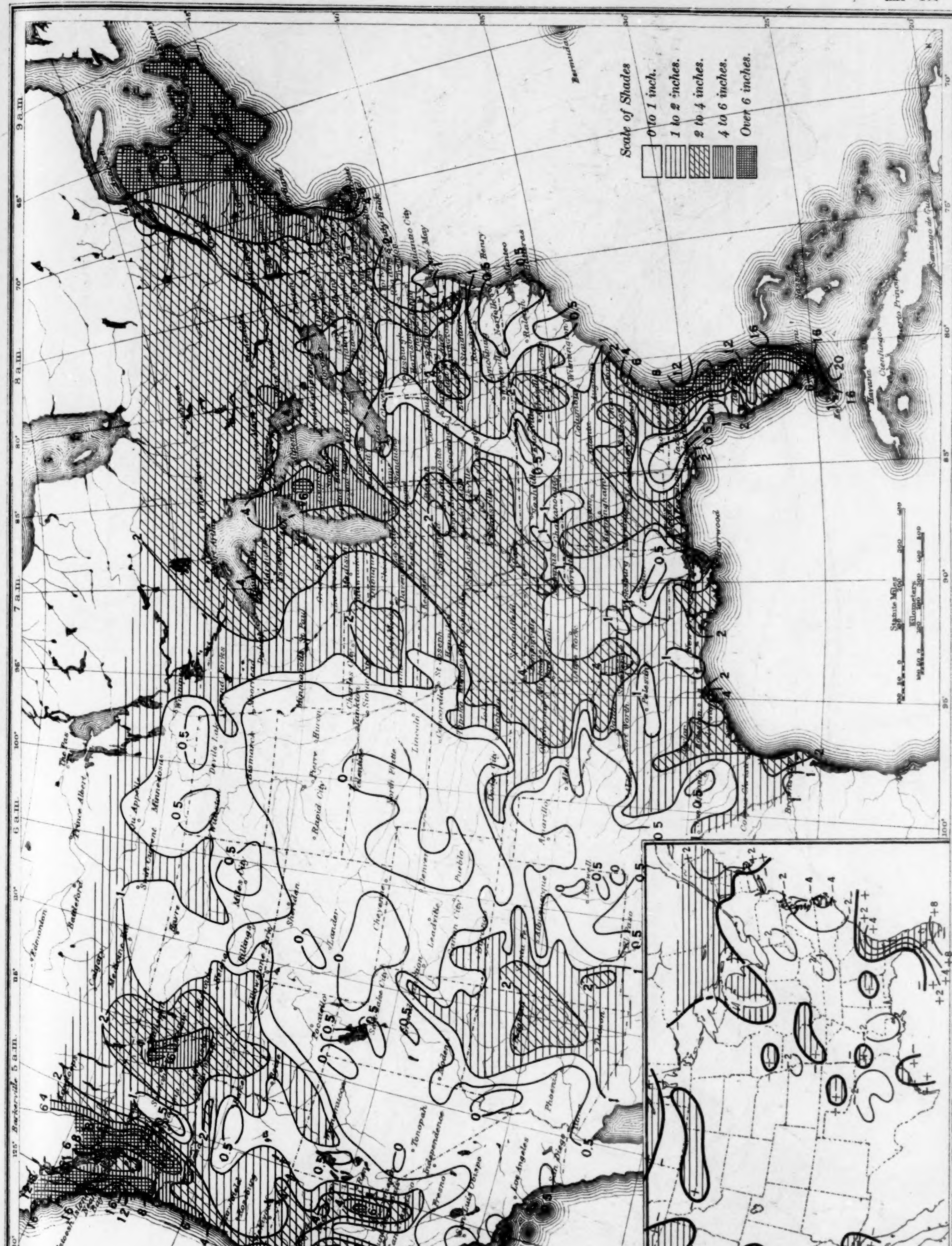


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, October 1933

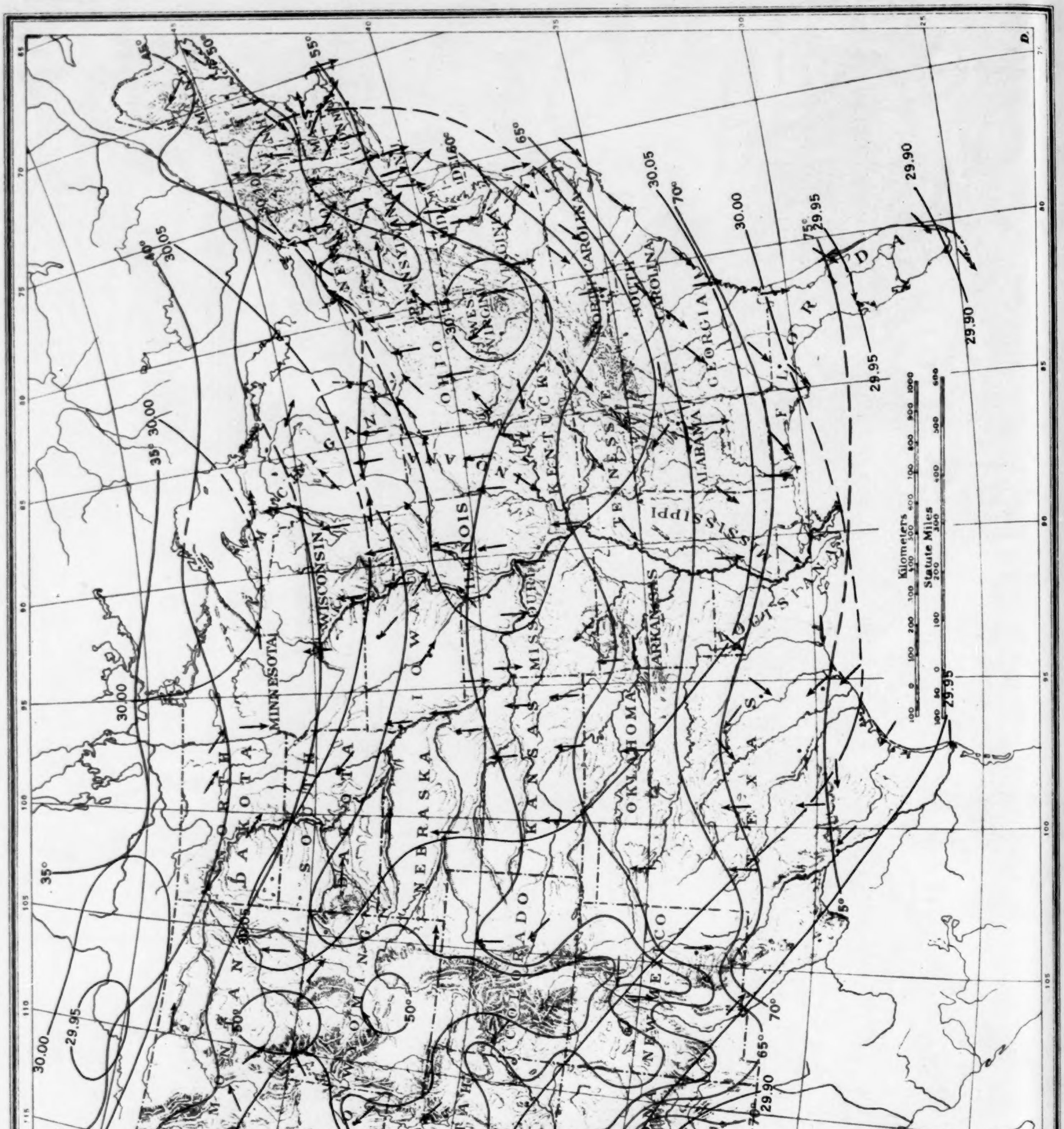
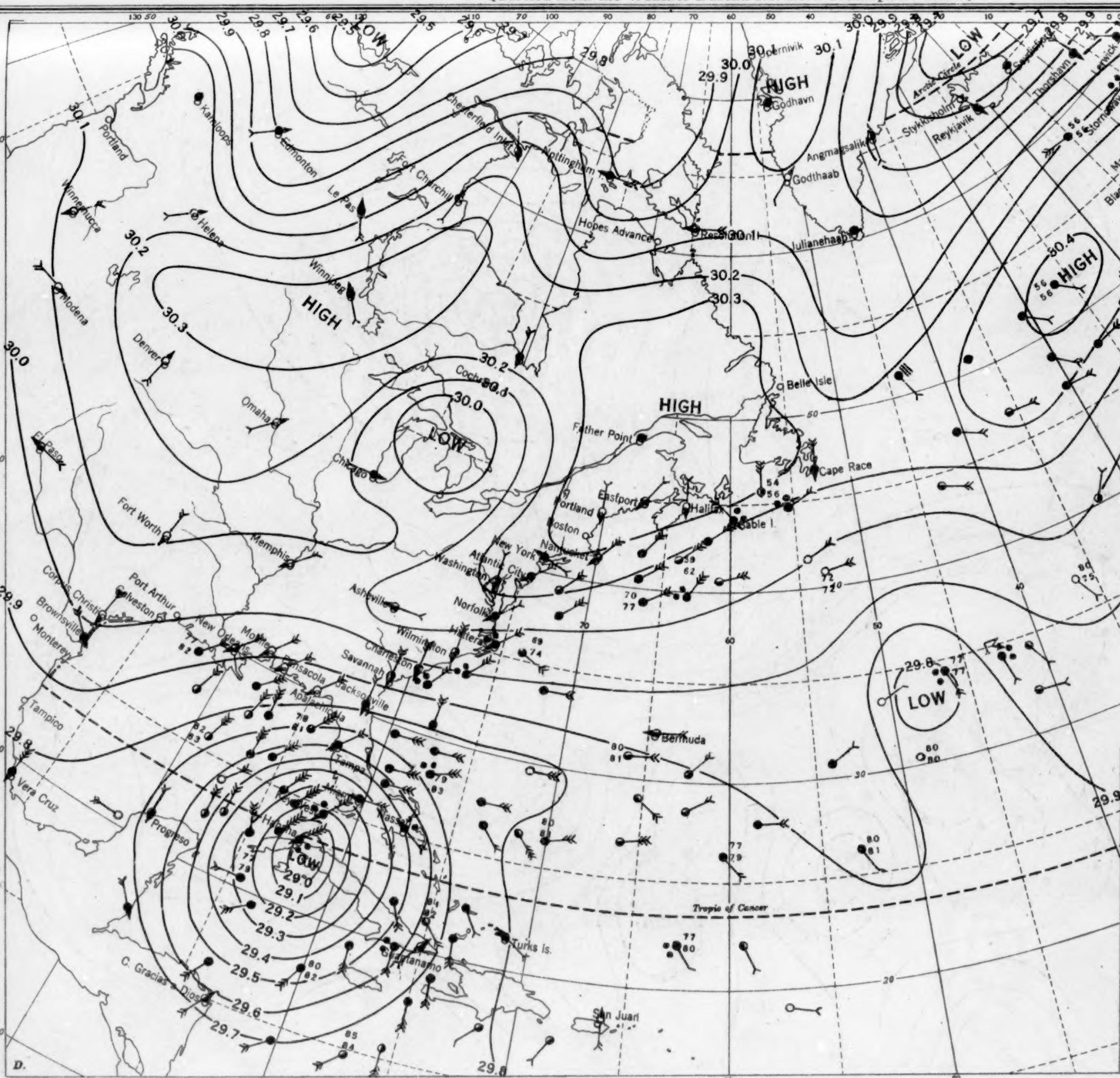


Chart VIII. Weather Map of North Atlantic Ocean, October 4, 1933
(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart VIII. Weather Map of North Atlantic Ocean, October 4, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

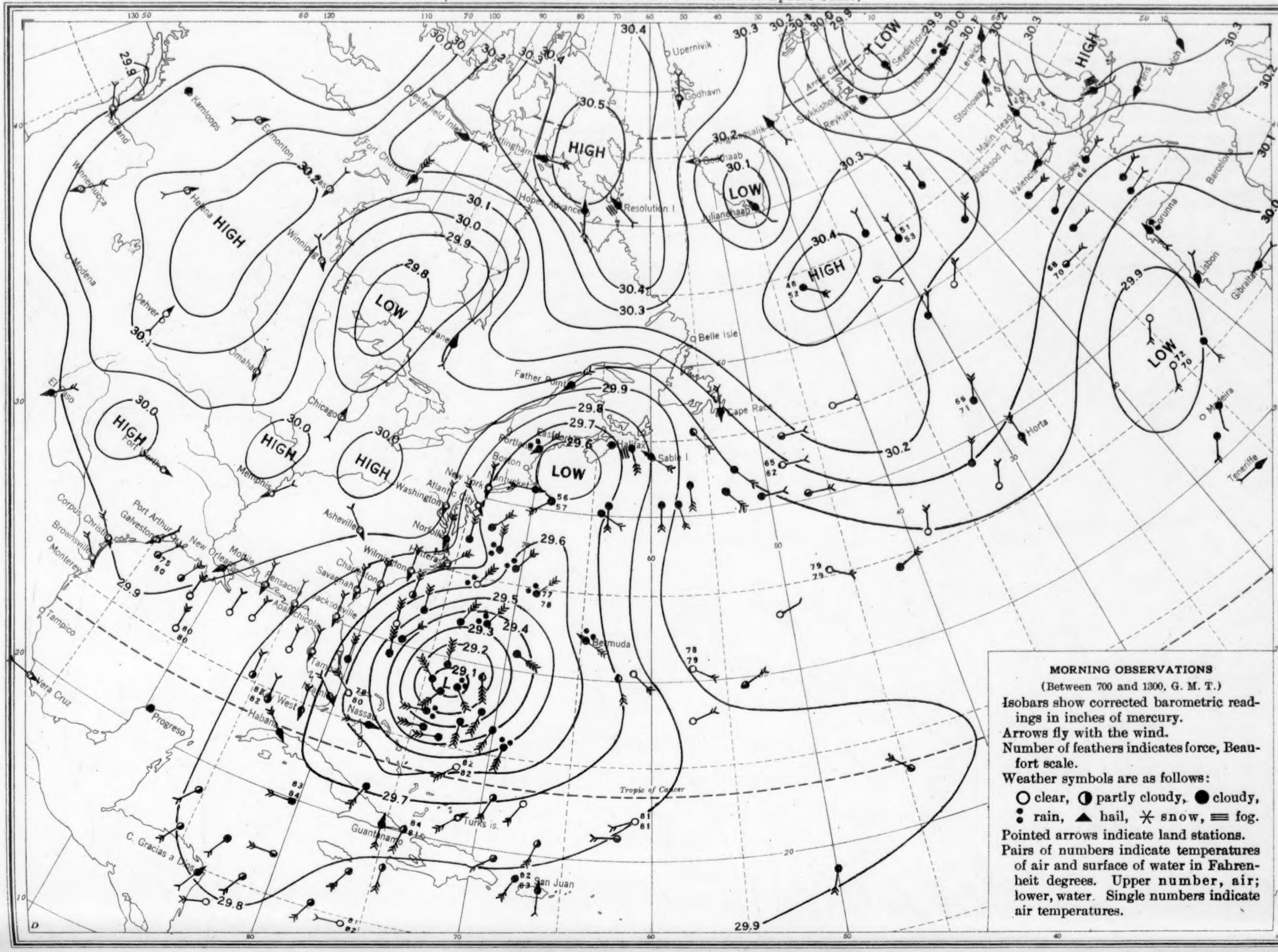
○ clear, ◑ partly cloudy, ● cloudy, ⁚ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart IX. Weather Map of North Atlantic Ocean, October 6, 1933

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

Chart X. Weather Map of North Atlantic Ocean, October 30, 1933
(Plotted from the Weather Bureau Northern Hemisphere Chart)

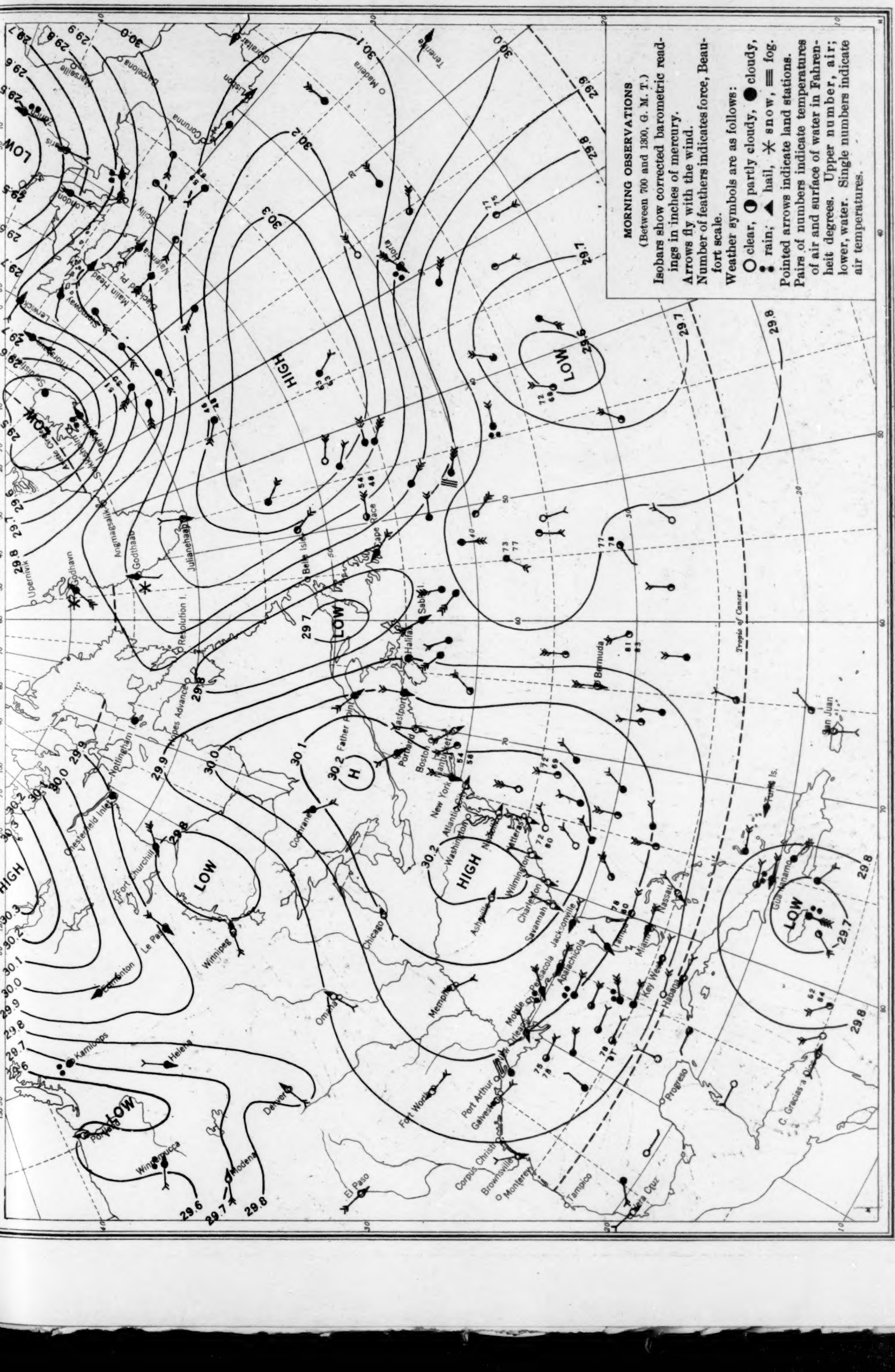


Chart XI. Weather Map of North Atlantic Ocean, October 31, 1933
(Plotted from the Weather Bureau Northern Hemisphere Chart)